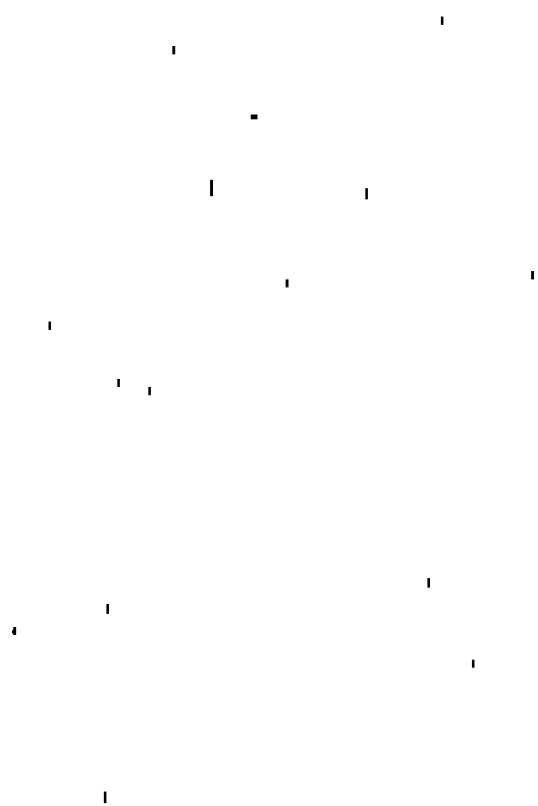


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MEMOIRS
OF THE
GEOLOGICAL SURVEY OF INDIA.

Palæontologia Indica,

PLATE.

**FIGURES AND DESCRIPTIONS OF THE ORGANIC REMAINS PROCURED DURING
THE PROGRESS OF THE GEOLOGICAL SURVEY OF INDIA.**

PUBLISHED BY ORDER OF HIS EXCELLENCY THE GOVERNOR GENERAL OF INDIA IN COUNCIL.

**TERTIARY AND UPPER CRETACEOUS FOSSILS OF
WESTERN SIND.**

Scr XIV.

Vol. I. 3. THE FOSSIL ECHINOIDEA.

**Fasciculus II. THE FOSSIL ECHINOIDEA FROM THE RANIE
SERIES OF NUMMULITIC STRATA IN WESTERN SIND.**

WITH 16 PLATES

BY

P. MARTIN DUNCAN, M.B. (Lond.), F.R.S., F.G.S., F.L.S.,

**PRESIDENT OF THE ROYAL MICROSCOPICAL SOCIETY; PROFESSOR OF GEOLOGY IN, AND FELLOW OF,
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PHILADELPHIA, ETC.**

AND

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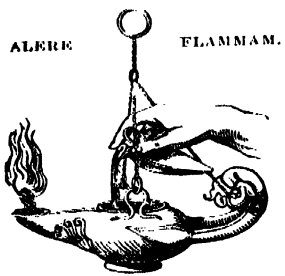
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A DESCRIPTION
OF THE
FOSSIL ECHINOIDEA
OF
WESTERN SIND.

FASCICULUS 2.—THE RANIKOT SERIES.

I. *Introductory Remarks on the Ranikot Series.*

THE stratigraphical relations and the nature of the deposits included in the Ranikot series of strata have been noticed in a former page*, and it is only necessary to remark that the strata rest immediately on a trap which covers the *Cardita-Beaumonti* series. The lower part of the Ranikot series consists of soft sandstones, shales, clays with gypsum and lignite, and pyritous shale. These freshwater strata are succeeded by highly fossiliferous marine limestones, often brown in colour, interstratified with sandstones, shales, clays, and ferruginous bands. Nummulites appear for the first time in the succession in this series; and there is a fine fossil Coral-fauna of 50 species. The depth of the Ranikot series is 2000 feet; and it is below the main Nummulitic limestone, which belongs to the succeeding age or that of the Khirthar series.

Although the nature of the fossil Echinoidea already described from beneath the trap which underlies the Ranikot series does not give any more satisfactory evidence than the fossil Corals regarding the age of their containing strata, still an Eocene facies predominates over a Cretaceous facies in the forms of the *Cardita-Beaumonti* beds.

It is evident that the Ranikot series is very low down in the Nummulitic series, and, whilst it contains relics of a somewhat modified Cretaceous fauna, the Eocene facies predominates.

The specimens forwarded by H. B. Medlicott, Esq., F.R.S., the Superintendent

* Page 4, fasciculus I.

of the Geological Survey, from the Ranikot series of Sind were numerous and in good condition. As was the case with the fossil Corals, we obtained little or no assistance from the work of MM. d'Archiac and Haime 'Sur les Animaux Fossiles de l'Inde,' although their types, fortunately at the Geological Society of London, were accessible. The wretched state of preservation of these forms and the diagrammatic nature of their illustrations have been a source of great perplexity to us. Wishing to give these authors every credit, and to determine their species if possible, we have constantly failed. The interesting memoir by M. de Loriol, entitled, 'Monographie des Echinides contenus dans les couches Nummulitiques de l'Egypte,' and that of Dr. W. Dames, of Berlin, 'Die Echiniden der vicentinischen und veronischen Tertiärablagerungen,' have been most useful to us indirectly as well as positively. It will be found that the fauna of this Ranikot series is a very remarkable one, and that it is as isolated as that described from Egypt by de Loriol.

II. *List of the Fossil Echinoidea from the Ranikot Series.*

Order ECHINOIDEA ENDOCYCLICA.

Family CIDADIDÆ.

Genus CIDADIS, Klein, 1734.

Cidaris Verneuli, d'Archiac: p. 26.

— *sp.: p. 25.*

Subgenus PHYLLACANTHUS, Brandt, 1835.

Phyllacanthus Ranikoti, Duncan & Sladen: p. 27.

— *Sindensis, Duncan & Sladen: p. 27.*

— *sp.: p. 28.*

Genus POROCIDARIS, Desor, 1854.

Porocidaris, sp. ? (spine).

Family SALENIADÆ.

Genus SALENIA, Gray, 1835.

Salenia Blanfordi, Duncan & Sladen: p. 29.

Family GLYPHOSTOMATA.

Subfamily DIADEMATIDÆ.

Genus CYPHOSOMA, Agassiz, 1840.

Cyphosoma abnormale, Duncan & Sladen: p. 32.

— *sp.: p. 33.*

Genus ACANTHECHINUS, Duncan & Sladen.

Acanthechinus nodulosus, Duncan & Sladen : p. 34.

Subfamily TEMNOPLEURIDÆ.

Genus DICTYOPLEURUS, Duncan & Sladen.

Dictyopleurus ziczac, Duncan & Sladen : p. 38.

Haimeï, Duncan & Sladen : p. 39, and variety, p. 40.

— *d'Archiaci, Duncan & Sladen : p. 41.*

Genus ARACHNIOPLEURUS, Duncan & Sladen.

Arachniopleurus reticulatus, Duncan & Sladen : p. 42.

Genus PROGONECHINUS, Duncan & Sladen.

Progonechinus Eocenicus, Duncan & Sladen : p. 43.

Subfamily ECHINIDÆ.

Section POLYPODI.

Genus EURYPNEUSTES, Duncan & Sladen.

Eurypneustes grandis, Duncan & Sladen : p. 46.

Genus ÆOLOPNEUSTES, Duncan & Sladen.

Æolopneustes de Lorioli, Duncan & Sladen : p. 48.

Order ECHINOIDEA EXOCYCLICA.

Suborder GNATHIOSTOMATA.

Family CONOCLYPEIDÆ.

Genus CONOCLYPEUS, Agassiz, 1840.

Conoclypeus Sindensis, Duncan & Sladen : p. 51.

— *?, sp. : p. 52.*

— *declivis, Duncan & Sladen : p. 53.*

*Suborder ATELOSTOMATA. **

Family CASSIDULIDÆ.

Subfamily ECHINOLAMPINÆ.

Genus PHYLLOCLYPEUS, de Loriol, 1881.

Phylloclypeus, sp. : p. 54.

Genus PLESIOLAMPAS, Duncan & Sladen, 1882.

Plesiolampas placenta, Duncan & Sladen : p. 54.

— *prælonga, Duncan & Sladen : p. 56.*

THE FOSSIL ECHINOIDEA

Plesiolampas ovalis, *Duncan & Sladen* : p. 58.

— *rostrata*, *Duncan & Sladen* : p. 61.

— *polygonalis*, *Duncan & Sladen* : p. 61.

Genus EOLAMPAS, *Duncan & Sladen*.

Eolampas antecursor, *Duncan & Sladen* : p. 62.

Subfamily ECHINANTHINÆ.

Genus ECHINANTIUS, *Breynius*, 1832.

Echinanthus enormis, *Duncan & Sladen* : p. 64.

Genus CASSIDULUS, *Lamarck*, 1801.

Cassidulus ellipticus, *Duncan & Sladen* : p. 65.

Genus RHYNCHOPYGUS, *D'Orbigny*, 1855.

**Rhynchopygus Calderi*, *d'Archiac*, sp. : p. 67.

— *pygmaeus*, *Duncan & Sladen* : p. 68.

Genus EURHODIA, *d'Archiac & Haime*, 1853.

Eurhodia Morrisii, *d'Archiac & Haime* : p. 70.

Genus PARALAMPAS, *Duncan & Sladen*.

Paralampas pileus, *Duncan & Sladen* : p. 73.

— *minor*, *Duncan & Sladen* : p. 74.

Genus NEOCATOPYGUS, *Duncan & Sladen*.

Neocatopygus rotundus, *Duncan & Sladen* : p. 76.

Family SPATANGIDÆ.

Subfamily SPATANGINÆ.

Genus HEMIASTER, *Desor*, 1847.

Hemiasster elongatus, *Duncan & Sladen* : p. 78.

— sp. (? *H. digonus*, *d'Archiac*) : p. 81.

Genus LINTHIA, *Merian*, 1853.

Linthia indica, *Duncan & Sladen* : p. 82.

— sp. : p. 85.

Genus SCHIZASTER, *Agassiz*, 1836.

Schizaster alveolatus, *Duncan & Sladen* : p. 87.

Genus PREMASTER, *Desor*, 1853.

Premaster oviformis, *Duncan & Sladen* : p. 90.

Genus METALIA, *Gray*.

Metalia Sowerbyi, *d'Archiac*, sp. : p. 93.

* Probably this species comes from a higher horizon.

III. *Description of the Fossil Echinoidea from the Ranikot Series of Nummulitic Strata in Western Sind.*

Order **ECHINOIDEA ENDOCYCLICA.**

Family *CIDARIDÆ.*

Genus *CIDARIS*, Klein, 1734.

The diagnosis of this genus need not be repeated in this work; but it is necessary to remark that the tubercles are usually perforate, but that they may or may not be crenulated. The pores are non-conjugate.

There are small portions of a *Cidaris* in the Ranikot group of strata, but they are not in a good state of preservation. On endeavouring to compare them with the types of the genus which were described and figured by MM. d'Archiac and Jules Haime*, we were surprised to find those carefully delineated fossils absolutely deficient in details of structure by which the species could be identified. The specimen of *Cidaris Halaensis*, d'Archiac & Haime, can be distinguished generically; but clearly the pores are non-conjugate, the tubercles are large, and the scrobicules are continuous above and below. No ornamentation or other details exist. *Cidaris Verneuili*, d'Archiac & Haime, has also a very bad typical specimen. The ambulacra are slightly wavy, the interporiferous zones are broad and have vertical series of broad roof-shaped elevations, two in each zone, and the pores are non-conjugate. In the interradia the scrobicules occupy the lower part of their plates, the median area is large, and the ornamentation is much obscured by the effects of sand-scrubbing. There are, however, more or less radiating series of separate small miliaries with furrows between them. It is with some hesitation that we place some plates in association with this species. The first specimens to be noticed do not belong to the species.

1. *CIDARIS*, sp. Plate V, Figs. 1-3.

In the indifferently preserved specimens the perforation and faint crenulation of the interradial tubercles can be distinguished. The interporiferous zone is moderately wide; and the roof-shaped plates have, in a well-preserved part of the fossil, two miliaries or very small tubercles on them. The pores are non-conjugate. The badly preserved ornamentation of the plates beyond the scrobicular circle is small and has no tendency to be in ridges or series, or to have furrows or lines in the midst. In some places the minute tubercles are elongate and either irregularly placed or alternate.

The ornamentation of the circle itself is much worn, and was larger than that beyond, being composed of small rounded tubercles.

The scrobicules are separate above and below, and a single row of small tubercles is between them and the well-marked suture. The areolæ occupy the greater part of the plates; they are sunken near their periphery, but the bosses soon project as bold cones,

* Animaux foss. de l'Indo.

the mamelon being small and perforate. The crenulation is distinct in the groove at the base of the mamelon, but it does not pass over the sides of the boss. There are from 8 to 10 pairs of tentaculiferous pores in relation to a large interrarial plate.

Locality. Ranikot group, north by east of Petiáni, west of Kotri. Survey-number G $\frac{280}{135}$.

Illustrations of the Specimens in Plate V.

- Fig. 1. An interrarial plate: magnified.
 2. A section of a plate: magnified.
 3. A portion of an ambulacrum: magnified.

2. *CIDARIS VERNEULI*, d'Archiac. Plate V, Figs. 6-8.

Cidaris Verneuli, d'Archiac, 1850, *Hist. des progrès de la Géol.* t. iii. p. 246.

— — —, d'Archiac & Haime, 1853, *Descrip. Anim. foss. de l'Inde*, p. 195, pl. xiii. figs. 1 a & 1 b.

Some large plates probably belong to this perforate non-crenulate form.

In the largest plate (Fig. 7) the scrobicular area occupies the larger part of the plate, and is separated from the sutural lines above and below, by the secondary tubercles of the circle and a few smaller ones beyond. These secondary tubercles are small, rather wide apart, and have bosses and mamelons. Beyond there is a circle of much smaller tubercles, which are also rather wide apart, and beyond there are irregular rows of large miliaries extending to the edges of the plates with suture-like lines between them. The whole of this ornamentation is on a convex surface which is slightly higher than the scrobicular area. The boss slopes gradually upwards and has a wide top, and a circular furrow is around the base of the mamelon. This has a constricted neck, a depressed convex top, and is largely perforate.

The width of the largest plate is $\frac{7}{8}$ inch; height $\frac{6}{10}$ inch.

Locality. Ranikot series, north-east of Petiáni, west of Kotri. Survey-number G $\frac{280}{135}$.

Illustrations of the Species in Plate V.

- Figs. 6 & 7. Plates of *Cidaris Verneuli*: natural size and magnified.
 8. A section of a plate (Fig. 7).

Subgenus PHYLLACANTHUS, Brandt, 1835.

Alexander Agassiz has pointed out that this subgenus has precedence of *Rhabdocidaris* of Desor. The group belongs to the genus *Cidaris*, and the subgeneric characters are broad interporiferous zones, pores conjugate, tubercles crenulate and perforate.

1. *PHYLLACANTHUS RANIKOTI*, sp. nov. Plate V, Figs. 9, 10.

There are fragments of three species of the subgenus *Phyllacanthus* in the Ranikot series. The specimens of one species belong to an old and younger forms, and in no case are they complete enough for a fair specific diagnosis.

What can be well observed is as follows:—

The ambulacra are slightly wavy, decidedly broad, and the poriferous zones are sunken; the interporiferous zone is at nearly the same level as the interrarial plates. The pores are conjugate, and each interporiferous plate has three small tubercles on it: one, the largest of the three, is a small, broad-based one, with a mamelon, and it is situated close to the plate bearing the pores; the others are minute and separate.

The ambulacral plates are numerous, and there are sixteen in contact with a large interrarial plate.

The interrarial plates, well separated by sutural markings, are faintly convex, and have a large areola which occupies their larger part. The scrobicule is circular in outline, very slightly sunken at its margin, and the boss projects as a broad cone terminating in a wide apex, on which is placed a small mamelon. Crenulation occurs on the grooved apex around the base of the mamelon, which is perforate.

A circle of distinct, small, broad-based tubercles, sixteen to twenty in number, is around the scrobicule; they are decidedly larger than those of rest of the ornamentation, which consists of two kinds of small tubercles. One, rounder than the other but more or less elongate, fits in more or less between the larger tubercles just mentioned; and the other kind consists of small elongate granulations, which radiate from the scrobicular circle of larger tubercles to the sutural marking. The larger scrobicules are rather close together above and below, and they are separated by the suture and a few minute tubercles, besides the rows of larger ones. But the smaller plates carry a few large and small ornamental tubercles near the suture, on the other side of which some little amount of space is occupied by the elongate ornamentation beyond the scrobicule. The median interrarial region is slightly sunken, and the ornamentation is only moderate in extent. The test appears to have been rather a high one.

The scrobicular circle of separate, small, tubercles is a striking feature in this species, as is also the fact of there being six vertical rows of minute tubercles in the interporiferous zone, which, of course, is broad. The great number of pores in relation to a large plate is very remarkable.

Locality. Ranikot series, in the higher part of the gypseous marls from hills east of Lynyan. Survey-number G $\frac{289}{126}$.

Illustrations of the Species in Plate V.

Fig. 9. *Phyllacanthus Ranikoti*, sp. nov. The plates: natural size.

10. An interrarial plate, with a portion of an ambulacrum: magnified.

2. *PHYLLACANTHUS SINDENSIS*, sp. nov. Plate V, Figs. 11, 12.

There is a fragment of a Cidarid in the collection, consisting of four interrarial plates and part of an ambulacrum, which appears to belong to the subgenus *Phylla-*

canthus, and to differ from the last mentioned. The ambulacra are broad, and there are two small miliaries, in vertical series, in the interporiferous zone of one side, and also a very minute third series. The number of pairs of tentaculiferous pores, in relation to an interradial plate, is probably about 10 or 12. The bosses of the interradial plates are well-developed, surmounted by a small mamelon, with a constricted neck, and rather depressed top, which is perforate. Crenulation is on the groove around the base of the mamelon. There is a row of small tubercles, about 16 in number, around the scrobicular circle, which is barely sunken, and beyond there are numerous smaller rounded tubercles, gradually diminishing to the size of miliaries close to the sutural edges. The scrobicules are separated from the upper and lower sutural edges by the single row of larger tubercles.

The locality of this species is in the Ranikot series, north by east of Petiáni. Survey-number G $\frac{280}{135}$.

Illustrations of the Species in Plate V.

Fig. 11. *Phyllacanthus Sindensis*, a portion of the test: natural size.

12. A plate: magnified.

Were there any pits within the scrobicular circles of these specimens, their alliance with the genus *Porocidaris* would of course be certain; but there are none.

3. *PHYLLACANTHUS*, sp. Plate V, Figs. 4, 5.

A very much worn specimen from the Ranikot series shows very indistinct remains of furrows close to the scrobicular circle, and converging towards the base of the boss. The ambulacra are moderately broad, the pores are conjugate, and the boss is crenulate at its groove around the small perforate mamelon. The scrobicule is moderately sunken, and is surrounded by a row of small secondaries, and beyond it are many irregularly placed and smaller rounded miliaries. It is impossible to determine the species, and, indeed, there may be some doubt about the genus, for so many of the Ranikot fossils are slightly sand-scrubbed, and it is amongst the number.

Locality. Ranikot series, north by east of Petiáni. Survey-number G $\frac{280}{135}$.

Illustrations of the Species in Plate V.

Fig. 4. *Phyllacanthus*, sp., a part of the test: natural size.

5. A plate: magnified.

Family SALENIADÆ, Desor.

Genus SALENIA, Agassiz.

Small swollen Urchins with a small peristome, barely marked with cuts. The ambulacra are flexuous, and composed of narrow, simple poriferous plates, ornamented only with small, closely placed granules. The interambulacral tubercles are very large, crenulate and imperforate. The apical disk is compact and has an undulating

contour; it is ornamented on its surface; and the sutures are usually punctured with isolated pits. There is a single suranal plate, placed in such a manner that a line drawn through its centre and the middle of the periproct reaches the other side of the anal ring and traverses an ocular and not a genital plate.

The species are Cretaceous, Eocene, Miocene, and Recent.

1. *SALENIA BLANFORDI*, sp. nov. Plate VI, Figs. 1-8.

The test is large, depressed, broader than high, flat at the abactinal surface, and narrower and slightly incurved at the actinal part, and convex at the ambitus.

The apical system is small, does not reach nearly to the edge, where the test becomes suddenly convex; it projects very slightly at the suranal plate, and is pentagonal or obscurely circular in outline. The anal opening is large, and is surrounded by a raised ring, which is highest where it is formed by the edge of the suranal plate, and lowest where the first ocular plate enters into its composition. The shape of the opening is an irregular oval. The madreporic genital plate (plate no. 2), irregularly triangular in shape, is smallest externally and broadest internally; it is of about the same dimensions as the third and fourth generative plates, being very slightly the larger. Its margins, like those of the other apical plates, are deeply and sparsely indented, and its generative pore is in the outer third; the small madreporic pit is raised and nearly central, and there is some minute pitting also. The plate does not reach the anal orifice, and is in contact with the generative plate on either side and with the suranal plate. The left anterior generative plate (the third) resembles the madreporic in its contour; it is flatter, and the pore is large. It touches the generative plates on either side, and joins the suranal by a dentate suture like the madreporic. The next plate in succession (the fourth) is of the same shape as those just noticed; and it is in contact with the suranal plate, but it does not enter the anal ring. The posterior generative plate (the fifth) is broad within, where it forms part of the anal ring, and small and pointed externally; it is shorter and broader than the others, and is unsymmetrical. Its pore is large and at the base of the ring. This plate is in contact with the plate just described (the fourth) and with the ocular plate which enters the anal system, and with the posterior edge of the suranal plate. The first generative plate resembles the fifth, and forms part of the anal ring; it is in contact with the suranal plate, and with the ocular plate (no. 1), and it is also in contact with the madreporic plate and the ocular plate (no. 2).

The ocular plates are wide and short from within outwards; they are curved within, and straighter without, with a projection pointing to the median line of the ambulacrum. They are subequal; but the first plate, the right posterior, is curved externally and broad within, and it enters into the composition of the anal ring, being united to a generative plate on either flank. The suranal plate is small, and may be slightly or decidedly smaller than the madreporic plate; it is indented at the orifice, where its margin forms a moderately developed ridge projecting obliquely; and it is in broad contact by processes with the madreporic, the left antero-lateral, and the left posterior lateral plates (that is, with plates 2, 3, and 4), and it touches by its

extremities the other generative plates which enter into the composition of the anal orifice.

The suranal plate is thus in contact with all the generative plates. One ocular plate, the right posterior lateral, enters into the composition of the anal ring, and so do the two generative plates, that is to say the first and fifth.

The ambulacra are narrow, slightly wavy in their course; the poriferous zones reach from the level of the test obliquely to the interporiferous zones, which are decidedly above the level of the interradia. The poriferous zones are narrow, and their plates are numerous and about 40 in vertical series. The pores are round and well open; and one is a perforation in an ambulacral plate, and the other of the pair, placed more or less obliquely and nearer the interporiferous zone, is formed by an excavation on the edges of two consecutive plates. Each of these last kind of pores is in the line of suture of the consecutive ambulacral plates, and each is separated from the other above it by a ridge continued from the base of the tubercle on the edge of the interporiferous area. The interporiferous zone has on either side a vertical series of small secondary tubercles with minute mamelons and non-crenulate bosses; and each tubercle corresponds to a broad part of an ambulacral plate. In the median space there are two parallel, vertical rows of large miliaries, of about the same number as the secondaries, and also a few microscopic granules.

The interambulacra are wide, and occupy much space at the peristome and around the apical disk.

There are four very large, projecting primaries; and in some areas there is a fifth, but slightly smaller, primary tubercle. The larger tubercles have a large boss with a circular shoulder to it, and a broad top which is crenulate. The mamelon is small, and has a decided neck and a rather flatly rounded top.

The scrobicular circle is distinct and is composed of a few small tubercles, with still smaller ones intercalated here and there. The circle is complete between the tubercles, but not between the tubercles and the poriferous zone. An irregular row of miliaries is beyond the circle on each plate. The space occupied by the small plate in each area, near the apex, is covered with a crowd of large miliaries; and these pass into the median line, but they soon become sparsely distributed there in two rows with an occasional intercalation. Near the peristome, where the small primaries are found, the miliaries increase in number.

The peristome is rather larger than the apical system, is somewhat deeply placed, is obscurely pentagonal or nearly circular in outline, and the cuts for the branchiæ are very small. The plates are numbered in this description according to Lovén.

Height of largest test $\frac{4}{10}$ inch; breadth $\frac{7}{10}$ inch.

Locality. Ranikot series, north by east of Petiáni, west of Kotri. Survey-number G $\frac{289}{135}$.

There is a small much worn specimen of a young *Salenia* in the collection from the same locality whence the other forms came. It has large primaries; and the ambulacral plates are singularly distinct and free from ornament.

Illustrations of the Species in Plate VI.

- Fig. 1. *Salenia Blanfordi*, Duncan & Sladen. The test: natural size.
 2. The apical system and upper surface: magnified.
 3. A larger specimen, showing the actinal surface: slightly magnified.
 4. The abactinal surface; magnified.
 5. A specimen: natural size.
 6. A portion of an ambulacrum: magnified.
 7. Three plates of the interradium: magnified.
 8. A young specimen: magnified.

This species of *Salenia* was especially noticed by Mr. W. T. Blanford, F.R.S., during the Survey of Sind, and he was good enough to examine it and to send a description of it to us. He noticed the remarkable smallness of the apical disk, and that one of the ocular plates enters the anal ring. These are the two distinctive characters of the form, which distinguish it from the European Nummulitic *Salenia Pellati*, Cotteau, and *Salenia tertiaria*, Tate, of the Miocene of Australia.

*Family GLYPHOSTOMATA.**Subfamily DIADEMATIDÆ.**Genus CYPHOSOMA, Agassiz, 1840.*

Test moderate in size, circular or subpentagonal, slightly inflated at the sides. General facies of test shows a regular and uniform development of its parts.

Poriferous zones well developed and undulated.

Pores simple, usually unigeminal throughout, sometimes bigeminal on the upper surface, and slightly crowded together around the peristome. The poriferous plates are unequal and irregularly arranged.

Primary tubercles nearly equal in both areas. Areolæ well developed and sometimes marked with radiated striations. Bosses prominent, summits sharply crenulated. Mamelon large, prominent, and imperforate.

Peristome moderate in size and with small cuts.

There are five specimens of a regular Echinid which come from the Ranikot series of Sind, and they are in a good condition. Four of the specimens belong to one species; but there is some doubt about the similarity of the fifth to them, notwithstanding the allowances that may be made for its being the youngest and smallest of the forms.

The species belong to the genus *Cyphosoma*, Agass.; but they are somewhat abnormal, on account of the want of correspondence in size between the ambulacral and interradian primary tubercles, the last-mentioned being decidedly the larger. The other structural characters clearly bring the forms within the generic idea; and therefore they are placed in it, especially as some variation between the dimensions of the tubercles of both areas has been noticed in some species in Europe.

1. *CYPHIOSOMA ABNORMALE*, *Duncan & Sladen*, sp. nov. Plate VII, Figs. 1-7.

The test is depressed, circular in marginal outline, very bulging at the sides, nearly flat at the abactinal surface, and slightly concave actinally, notwithstanding some convexity of the areas around the rather small sunken peristome.

The apical system is small; details not preserved.

The ambulacra are comparatively narrow, and enlarge moderately only, at the ambitus; they are not quite one half of the breadth of the interradial areas at the most convex part of the test, and the broad poriferous zones are on a slightly lower level than the interporiferous areas.

The pores are very small and numerous, bigeminal, and more or less in arcs from the ambitus to the apical system, and in slightly arched simple series near the peristome.

At the ambitus the ambulacral tubercles are larger than elsewhere, and they diminish in size more suddenly towards the peristome than towards the apex, and they are less numerous in the former direction. The larger tubercles have a broad circular base; the boss slopes gradually upwards to a well-developed neck, which is surmounted by a small mamelon, rather flattened at the summit and imperforate. The crenulation is distinct. A scrobicular circle of a few large and small miliaries is around each tubercle; and near the poriferous zone the larger of these miliaries are in relation to a poriferous plate, a line of depression intervening between the successive miliaries. A small secondary tubercle is seen, here and there, at the ambitus, and usually they are placed, solitarily, between the vertical series of larger tubercles. Near the apex the tubercles are small, and the circle of smaller tubercles is ill-defined; but there are a few tubercles of intermediate size in vertical series. Still nearer the ambitus the tubercles are larger, and begin to assume the character of those at the ambitus. Near the peristome there is a short close vertical series of small tubercles of intermediate size, followed by wider-apart ones, which gradually become typical tubercles. In the close series the scrobicular circle of miliaries is not seen; but it commences directly there is any appreciable distance between the tubercles.

The interradial areas are wide, even at the apex; and their tubercles are small away from, and large and projecting at the ambitus; they are larger than those of the ambulacra. A large tubercle at the ambitus, has a broad base, a slanting conical boss, which is broadly crenulate, with a large and narrow neck and a small, rather flat mamelon. The scrobicular circle, of a single row of large miliaries, is incomplete between the vertical series of tubercles, but nearer the apical system it is nearly complete. There, the tubercles are wider apart, and the miliary circle is sparsely furnished. At the actinal surface the tubercles are larger than at the apex, and the scrobicules of the vertical series are not separated.

The median area of the interradials is wide and very sparsely ornamented with large and small miliaries near the apex, a very few small tubercles with crenulated bosses being placed in alternate vertical series near the median line of suture. They are largest at the ambitus.

Between this series and the scrobicular circles are large miliaries, many with a

sharp point; they form rather indefinite scrobicular circles around the small tubercles; and others are dotted about here and there, sparingly. Hence the ornamentation is distinct, sparing, and unequal in the median area, and it passes in arcs on one side of the great tubercles.

Between the scrobicular circles of the interradians and the poriferous zones, the ornamentation consists of a vertical series of small tubercles, unequal in size, and of a few large miliaries. This ornamentation diminishes near the apical system, and a few miliaries are seen near the poriferous zones. A similar diminution occurs near the peristome in the ornamentation of this particular region. There are traces of an indefinite ribbing down the flanks of some of the bosses of the interradian area, near the poriferous zones.

Dimensions. Breadth of the specimen $1\frac{3}{10}$ inch; height rather more than $\frac{1}{2}$ inch.

Locality. North by east of Petiáni, west of Kotri. Ranikot series. Survey-number G $\frac{289}{135}$.

A second specimen is smaller than the type and evidently younger. The height is $\frac{1}{2}$ inch, and the breadth $1\frac{2}{10}$ inch. The ornamentation is less elaborate than that of the type; but the large miliaries of the plates near the apical system, in the interradia, are better defined in their circular arrangement. The specimen came from the same deposit as that just described.

A small form clearly belongs to this species; and the principal distinction is one of age, and relates to the ornamentation, which is more scanty.

Further, a small form has to be noticed; and its value is in the preservation of the peristomial margins. The peristome is small, and the cuts are very small. The poriferous zone is simple, and the more or less arched series of pores is unigeminal, except in one or two spots near the apex in some zones. It is from the same locality; and the dimensions are, breadth $\frac{7}{10}$ inch and the height $\frac{3}{10}$ inch.

Illustrations of the Species in Plate VII.

Fig. 1. *Cyphosoma abnormale*, Duncan & Sladen. The side view of a large specimen: natural size.

2. The abactinal surface: slightly magnified.
3. A small specimen: magnified 2 diameters.
4. An ambulacrum of the large specimen: magnified.
5. The interradian tubercles, near the ambitus, of the smaller specimen: magnified.
6. The poriferous zone and the adjoining ambulacral and interradian plates, near the peristome, of the larger specimen: magnified.
7. An interradian plate of the large specimen: magnified.

2. *CYPHOSOMA*, sp. Plate VII, Figs. 8, 9.

A small specimen of a rather worn *Cyphosoma* is in the Ranikot series collection, and is from the same locality as the other forms. Its tubercles are small, and there is not much distinction in size between those of the different areas. The pores are in

arcs and in simple series, and the ornamentation is very simple. Possibly it may be a young specimen of the species just described.

The breadth is $\frac{6}{10}$ inch, and the height is not quite $\frac{1}{10}$ inch.

Illustrations of the Species in Plate VII.

Fig. 8. The test: natural size.

9. A poriferous zone and adjoining areas: magnified.

There are two fragments of a test of a *Cyphosoma* from the locality which yielded the more perfect specimens. One is part of a large form of the species just described; and the other belonged to a large test of another species. This test is characterized by the elaborate ornamentation which exists between the vertically placed tubercles, whose scrobicular circles are distinct. The intervening space is ornamented with small tubercles, with mamelons and indefinite scrobicular circles of miliaries, and with some large and small miliaries, which are irregularly placed.

Genus ACANTHECHINUS, gen. nov.

A large fragment of a regular Echinid allied to the Diadematidæ, without apical and actinal portions, and showing one half of the rest of the test, is in the collection from the Ranikot series. The details of the structures of the test are unlike those of any known genus. The description of the specimen can only relate to the general shape and the details of the ambulacral and interradial areas.

We propose to include this form as a new genus; for although it has some of the characters of *Stirechinus*, Desor*, there are generic distinctions to be observed between them.

Test turban-shaped. Ambulacra convex from side to side, one half the breadth of the interradial areas, with two incomplete vertical rows of primaries. Pores in numerous pairs, forming a double series near the apex only. Interradials with sunken median areas, plates distinctly sutured and high. Primary tubercles of both areas well developed, some on raised areolæ, all with a broad-based tumid boss and a small mamelon; they are imperforate, but largely crenulate, with ridges passing down their flanks. Secondaries or large miliaries sharply pointed and spiny.

The species may be called *Acanthechinus nodulosus*.

1. ACANTHECHINUS NODULOSUS. Plate VIII, Figs. 1-3.

The original shape of the test was probably turban-shaped, or depressed and circular, or subpentagonal in marginal contour. It was flat actinally, bulged at the ambitus and for a short distance above, and it sloped gradually upwards to the apex, being less convex there.

Compared with the interradials, the ambulacral areas are small, but nearly as prominent. At the ambitus the width of the ambulacrum is not more than that of one

* Desor, 'Synopsis des Echinides Fossiles,' p. 131. *Stirechinus Scillæ*, Desor, = *Echinus Scillæ*, Desm., from the Pliocene of Palermo and Monte Mario.

half of the interradial area. The ambulacra are narrow, and are convex from side to side. There are a few primaries in the interporiferous zone. They are small at the apical end, enlarge gradually towards the ambitus, and cover much of their plates there. They are in two alternate vertical rows, and have broad bases, tumid bosses, and small mamelons. The bosses are crenulate, and also ridged down their flanks; they are upon slightly raised areolæ, which are marked with linear depressions and intermediate ridges in connexion with the poriferous plates. The sutures between the plates of the interporiferous zones are distinct; and between them and the base of the mamilliform processes are a few large miliaries in an incomplete circle, and they are sharply pointed or nodulose, and are usually oblique in their direction. The crenulation takes on the form of nodules more or less sharp, and ridges with intermediate furrows, and there may be pointed granules on the bosses. The small mamelon has a constricted neck and is imperforate.

Every plate of the interporiferous zone has not a primary tubercle on it, and there are small wedge-shaped plates between the tubercle-bearing ones in vertical series. Hence the tubercles are rather wide apart, one above the other. The intermediate plates are furrowed at their edge in the direction of the poriferous plates, and they have a few oblique and sharp-pointed miliaries on them. They have well-marked sutures, and are comparatively smaller at the ambitus than near the apex?

The poriferous zones are narrowest actinally, and slightly largest near the apex; they are placed obliquely on the test, on the lateral slopes of the ambulacra. The number of plates is considerable, and there are from 10 to 17 in contact with the larger interradial plates. The pores are crowded vertically, but only form a double series near the apex, although there is much close alternation or serial succession elsewhere. Near the actinostome they are in single vertical series. They are conjugate, small, slightly elliptical or round; and each plate has raised margins above and below, which form between them hood-shaped openings and tubular furrows. These margins become broken ridges in some places, and may have a miliary tubercle upon them. The number of pairs differs in relation to the primary ambulacral plates, and there are often five or eight pairs.

The interradial areas are large, have their sutures very visible, the median space sunken, and the projecting centre of each plate occupied by a very projecting large primary, which is flanked by a surface on which are placed a few spiniferous large miliaries, and some small miliaries here and there.

The bosses are placed on raised scrobicules, surrounded by a more or less complete circular furrow; they are tumid cones, with a broad apex and wide base, are furrowed and ridged on the flanks, and crenulate and nodular above. The mamelon is small, has a tall constricted neck, and is therefore high; it is imperforate. There are eight plates from the ambitus to the apex, in each half of the area; and they are very broad near the margin, and diminish in breadth, and increase slightly in height, towards the apical system.

The length of the test is $\frac{8}{10}$ inch; the greatest width of the ambulacra $\frac{7}{30}$, and of the interradial areas $\frac{5}{10}$ inch.

Locality. In the Ranikot series, hills east of Lynyan, from the brown limestone:
Survey-number G $\frac{126 \times}{280}$.

Illustrations of the Species in Plate VIII.

- Fig. 1. *Acanthechinus nodulosus*, Duncan & Sladen. The remains of the test.
natural size.
2. Ambulacral and interradial plates at the ambitus: magnified.
3. A primary tubercle: magnified.

Subfamily TEMNOPLEURIDÆ.

This subfamily, on account of the late discovery of other fossil and recent forms than it formerly comprehended, must be considerably enlarged. A critical examination of the genera and species hitherto included in the subfamily, and a careful morphological study of one group of the genera, necessitate its division into two groups, which probably may each form a subfamily. It is unfortunate that the genus *Temnopleurus*, which is not represented by species in the Nummulitic series, and which is apparently a recent development, should have given the name to the subfamily, many of the genera of which are found fossil. The morphology of the test of the genera *Temnopleurus*, *Salmacis*, *Amblypneustes*, and *Pleurechinus** is peculiar, and the true pits at the sutural angles undermine the test, whose plates are united by knob and socket suturing. These morphological details are not found in *Temnechinus* and the forms found fossil in the Nummulitic of Sind, although some of them have been classified as species of *Temnopleurus*.

Nothing is more distinct than the structure of the outside of the test of the genus *Temnechinus*, and the genera we associate with it, and that of the genus *Temnopleurus* and the genera already noticed in relation to it. In the one the raised ornamentation produces the appearance of depressions along the whole line of the sutures, especially of the horizontal sutures; and in the other there are, besides, deep pits at the sutural angles and a special method of union of the plates. The structure of the apical system is peculiar in some of the genera associated with *Temnechinus*, and differs from that of *Temnechinus* itself. The apical system of the Temnopleurids with true pits appears to be tolerably uniform, and to be fashioned upon the plan of *Temnechinus*. Crenulation and non-crenulation of the tubercles exist in both of the groups.

We have had the advantage of examining a very perfect specimen of a *Glyphocyphus* from the Upper Greensand of England, and also of studying the plates of other species drawn under the direction of Cotton and Wright. Our form is clearly of the subfamily Temnopleuridæ; but it does not belong to the group with true sutural pits, but to that with Temnechinid sutural depressions.

The diagnosis of *Glyphocyphus* is given in d'Archiac and Haime's 'Animaux

* P. Martin Duncan, Journ. Linnean Soc. vol. xvi. p. 243, 1882, and *ibid.* p. 448.

Fossiles de l'Inde.' It includes small urchins, more or less swollen, with straight and simple poriferous zones. The peristome is small and sunken, and the apical disk narrow and annular. The tubercles are small, usually not very distinct, and are crenulate and perforate; they arise from the midst of a close miliary granulation, which forms a kind of star around each tubercle. The interambulacral plates have their sutural lines distinct and even slightly grooved, so as to give the test a sculptured appearance. Desor is mistaken in asserting that the tubercles are neither crenulate nor perforate. In the delineations of Goldfuss of the species nothing can be made out satisfactorily; but in Desor's pictures of *Glyphocyphus radiatus* the whole of the ocular plates come into the oral ring, and the primary tubercles have a vertical ridge uniting them. The tubercles are perforate and crenulate in British specimens, and in *Glyphocyphus conjunctus* (the *Arbacia conjuncta* of L. Agassiz) the whole of the tubercles are united by elongate granules, but the aboral lines are not so distinct as in the type of the genus. In *Glyphocyphus Neocomiensis*, Cotteau, the tubercles are both crenulate and perforate.

Glyphocyphus may be considered to be the type of the group of which *Temnechinus* forms a part.

In the Ranikot series of Sind, which is at and above the base of the Nummulitic strata, several remarkably ornamented Echini have been found by the Geological Survey of India under Messrs. Blanford and Fodden.

Others had been discovered many years since and were sent to MM. d'Archiac and Jules Haime for description in their great monograph 'Sur les Animaux Fossiles de l'Inde.' They were described in that work and figured, and were returned to the Geological Society of London. The descriptions are long, and the drawings are exquisitely definite; but the specimens themselves are not in a condition to satisfy us even about their generic position, from the light cast upon them by the beautiful specimens belonging to forms from the same area and in our hands.

We are not satisfied that they have true pits at the sutural angles; and it appears to us that the various species are members of one of the groups typified by *Glyphocyphus* of the subfamily with raised ornamented ridges and depressions over the sutures.

The drawings in 'Les Animaux Fossiles' have misled Desor and A. Agassiz; and in the report on the 'Challenger' Echini there is an exquisite drawing by this last-mentioned author of a *Pleurechinus*, which he compares with *Temnopleurus Valenciennesi*, D'Archiac & Haime. In *Pleurechinus bothryoides* of Japan the ornamentation is raised, and the sutures are distinctly penetrated by a deep depression at the angle of the plates. It is a true Temnopleurid. But an examination of the type from Sind drawn by Messrs. d'Archiac and Jules Haime proves that it was so weathered that the imagination of the draughtsman was founded on miserably defective structural details. The drawing in the plate of the great work is absolutely a restoration. No deep pits are to be seen at the angles.

The specimens of Echini with raised ornamented ridges and without penetrations at the angles of the sutures, and which were derived from the Ranikot series of Sind, are numerous. Some are beautifully preserved, others are so in parts, and a few have been so weathered and worn that they might almost be placed in different genera.

The well-preserved specimens indicate clearly that they have a most elaborate raised ridge-like ornamentation, and no sutural depressions and penetration; and the badly-preserved ones have the appearance of deeply-bevelled sutures, and as if the test had been cut out, instead of added to, in thickness.

Genus DICTYOPLEURUS, gen. nov.

The test is small, hemispherical above, slightly concave below, with a small peristome and small cuts. The pairs of pores are in continuous straight series. The tubercles of both areas are very small. Those of the ambulacra are in two vertical series close to the pores, and each tubercle is united by a vertical raised ridge with those above and below, and by a zigzag of raised ridges with those of the other vertical series opposite. The tubercles of the interradial areas, in two vertical series, are on vertical raised ridges or ribs. Each tubercle is continuous with two of the opposite series by a raised ridge, and sends off two or three ridges to the poriferous zone. The tubercles are faintly perforate and slightly crenulate, and there are indications of a few secondaries around them. The perforation and crenulation is indistinct in the ambulacral areas. Here and there the narrow raised ribs have small granules upon them. The sutural lines of the plates are distinctly seen, and there are no depressions or penetrations of them. The apical system, obliquely placed, is elongate; and one ocular plate enters the anal ring.

1. DICTYOPLEURUS ZICZAC, *Duncan & Sladen*. Plate IX, Figs. 1-3.

The test is small, hemispherical above the rather tumid ambitus, which is circular in outline, and slightly concave actinally, where there is a small sunken peristome with slight cuts.

The apical system is large for the size of the test, is placed obliquely, and the anus is elongate and elliptical in outline. The direction of the long axis is as in an *Echinometra*. The ring of generative plates is narrow; and one ocular, the right posterior, enters into the composition of the anal ring. The madreporic body rises like a small knob, and its plate is the largest; none of these plates enter far into the interradial areas. The ocular plates have triangular depressions on their sutures on either side of a vertical line, and the pore is visible near the apex of the blunt angular projection.

The ambulacra, about one half of the breadth of the interradials at the ambitus, have two vertical series of small tubercles on narrow, raised, rounded ridges, placed close to the poriferous zones. The tubercles are small, very faintly perforate and crenulate, and they increase in size and number actinally. The interporiferous zone is crossed by a zigzag of raised ridges, which unite the opposite and alternate tubercles on the vertical ridges. Much of the surface of the plates is seen on either side of the ridges, and the sutural lines are distinct; these cross over the ridges in young specimens. The pairs of pores are in single rows, and there are three pairs opposite each interradial

plate; they are rather large, and some perforate the ridge which passes from the ambulacral raised ridge to that of the interradial area. The interambulacra are broad, and have two vertical, narrow, raised ridges, on which are placed the twelve small primary tubercles. The ridges are rounded, sometimes have a single granule here and there; and the tubercles are largest near the ambitus, being very faintly perforate and crenulate, and occasionally surrounded by a circle of small miliaries. The median interambulacral space is occupied by a zigzag of slightly curved, narrow, rounded ridges, smaller than those of the vertical series, and extending from the tubercles of one series to those of the other in oblique paths. These ridges sometimes carry a large granule or two.

The coronal plates are very visible between the cross ridges, and the sutural lines are very distinct. Like those of the ambulacra, the sutures do not mark the ridges in the larger specimens, but they cross them in the younger. Between the interradial tubercles and the ambulacra there are groups of two or three ridges passing obliquely off from each tubercle; these pass between the poriferous plates, and are sometimes perforated by the pores, and finally unite with the adjoining vertical ridge of the ambulacrum.

Height of test $\frac{1}{10}$ inch, breadth $\frac{3}{10}$ inch.

Locality. North by east of Petiáni. Ranikot series. Survey-number G 283.

Illustrations of the Species in Plate IX.

Fig. 1. The test of *Dictyopleurus ziczac*: natural size.

2. The apical system: magnified.

3. An ambulacrum and interradial area: magnified.

2. *Dictyopleurus haimei*, sp. nov. Plate IX, Figs. 4, 5.

The test is small, tumid at the ambitus, which is circular in outline, conical above, rather flat actinally, and sunken at the small peristome. Apical disk wanting, but its direction appears to have been oblique. The ambulacra are much narrower than the interradial areas; the poriferous zones are narrow, and consist of a continuous single series of pairs of pores, which usually penetrate ridges connected with the interradial tubercles. There are three pairs of pores to each interradial plate. Immediately within the series of pores is an indistinct raised ridge; it is vertical, thin, straight, and discontinuous, here and there carrying very small tubercles; these are largest near the actinal surface, and have swollen bosses and small mamelons. Crossing the space, in the interporiferous region, between these vertical ridges is a series of oblique narrow ridges, sometimes linear, at others thicker, and ornamented with one or two rows of miliaries. These pass from one tubercle to those of the opposite series above and below; and there is distinct space between them in which the sutures can be seen. Here and there the zigzag becomes disorderly.

The interambulacral areas have two vertical narrow ridges, one on each coronal

series; they are more or less discontinuous where the small crenulate and perforate primaries exist. These are in slightly sunken scrobicules. Actinally the scrobicules are in contact with the vertical ridge, which usually has a row of miliaries on it. On either side, and abactinally to the scrobicule, is a raised ornamentation (on the base of which rests the scrobicule) extending on either side, and marked with two or three horizontal rows of miliaries. Towards the ambulacrum this ornamentation divides into three ridges, which are continuous with the poriferous plates, and towards the median line into two ridges, which unite with those of the tubercles above and below of the neighbouring column. The ridges are narrow and miliary, and the spaces between them, and on the bottom of which the coronal plates and distinct sutures are seen, are elongate transversely, being crossed vertically by the raised ridge between the small primaries.

There are no penetrations of the test at the sutural angles. Actinally the spaces between the ridges become deeper and smaller.

Height of the test $\frac{3}{10}$ inch, breadth at the ambitus $\frac{4}{10}$ inch.

Locality. Hills east of Lynyan, from brown limestones. Ranikot series. Survey-number G $\frac{289}{127}$, G $\frac{280}{128}$, G $\frac{226}{128}$.

• *Illustrations of the Species in Plate IX.*

Fig. 4. *Dictyopleurus Haimeï*, Duncan and Sladen: natural size.

5. Part of an ambulacrum, and interradial area: magnified.

Dictyopleurus Haimeï, Duncan & Sladen, variety.

There are some small specimens of this species in the brown limestone whence the type was derived; and they seem almost to unite the species *Dictyopleurus costatus* and *Dictyopleurus d'Archiaci*. They would be considered young forms of *Temnopleurus*,



Dictyopleurus Haimeï, var.

and might be classified with one of the species of that genus described by MM. d'Archiac and Jules Haime; but they are not members of the genus *Temnopleurus*.

The main distinction of these specimens from the type of *Dictyopleurus Haimeï* is that the bands of transverse raised ornamentation on the interradium are not so split up and are higher; the bands unite along the median line by short processes, or their angles

join. The distinction from *Dictyopleurus d'Archiaci* is, that in the variety there is a vertical line of raised tissue in the interradium on either side, connecting the vertical row of tubercles together. The test is very thick; and the transverse depressions over the sutures are deep and much broader than high. There are no pits in the test at the sutural angles.

3. *Dictyopleurus d'Archiaci*, sp. nov. Plate X, Figs. 5-8.

The test is small, conico-turban-shaped, swollen at the ambitus, and sloping gradually to the apex with a gentle curve. The actinal part is rather flat but slightly convex, and the actinostome is sunken and small. The apical system is deficient.

The ambulacra are narrow, the poriferous zone slightly sunken; and the pores are in simple vertical series, and about three to each interradial plate; they are on slight ridges. The interporiferous zone has a ribbed ornamentation which crosses it, leaving rather irregularly-shaped depressions on either side of the median line; these are deep, square, or irregularly oval and triangular spaces, and are largest above the ambitus. There are also transverse linear depressions; the number of plates is considerable, and the ridges on them are of different lengths. A vertical row of small primaries is on either side just within the poriferous zone; and the tubercles are raised on the ridges, have a tumid boss and a small mamelon; they are faintly crenulated. A close ornamentation of large miliaries, some of which are very distinct, covers the ribs of the ornamentation. The interradial areas are marked with well-developed ornamented transverse ridges leaving rectangular furrows between them, whose transverse continuity is arrested by the primary tubercles. The ridges are broad and high; moreover they project well from the test; they are rectangular, have their actinal edges slightly wavy, and are ornamented by three transverse rows of well-developed miliaries. Each one is connected with the ambulacral poriferous plates by a narrow short ridge, and with its fellow, on the opposite side of the median line, by a very short process from each upper and actinal angle. There are two vertical rows of primary tubercles on the interradial areas, and a primary is thus situated in the midst and towards the actinal edge of the ornamented ridge. It is large for the dimensions of the plate, is surrounded by a linear scrobicular circle, and has a tumid boss and a small mamelon. Crenulation and perforation exist. The actinal edge of the tubercle impinges on the plate below; but no vertical ridge is observed in the perfect form.

Height of specimen $\frac{1}{4}$ inch, breadth $\frac{7}{16}$ inch.

Locality. Hills east of Lynyan, from brown limestones. Ranikot series. Survey-number G $\frac{280}{127}$.

The specimen which has been taken as the type has been weathered, except close to the supporting piece of rock, and the furrows over the lines of the sutures are very distinctly shown. In the ambulacra, the larger plates which supported the primary tubercles are projecting, and there is a vertical ridge between the raised ridges of the interradial areas in relation to the primary tubercles.

Another specimen, which has been well weathered, shows these points more distinctly, and is delineated on Plate X, Figs. 7 & 8.

*Illustrations of the Species in Plate X.*Fig. 5. *Dictyopleurus d'Archiaci*: natural size.

6. A portion: magnified.

7. A weathered specimen: natural size.

8. A portion: magnified.

Genus ARACHNIOPLEURUS, gen. nov.

The test is circular in marginal outline, depressed, tumid at the ambitus, and rising but slightly above it. Peristome deeply sunken and small, and cuts small. Apical system large, deficient in details. Ambulacra narrow; pores uniserial, in slight curves, penetrating ridges which are continuous with tubercles on the scrobicular circles. Tubercles small, in vertical series, perforated and crenulate, with very large scrobicules raised above the test; small secondaries in a single row on the raised scrobicular circle, and radiating ridges connecting them with the boss. Small nodulose ridges or ribs uniting the secondaries of each vertical series to those on the scrobicules of the adjoining vertical series and also to the poriferous zone. Plates and sutures visible between the ridges.

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1. *ARACHNIOPLEURUS RETICULATUS*, sp. nov. Plate IX, Figs. 6-8.

The test is small, depressed, faintly conical abactinally, depressed actinally, with a small deeply-sunken peristome with small cuts.

The ambulacra have two rows of small perforate and crenulate tubercles situated close to the poriferous zone. They are largest at the ambitus, and very small near the apical system. Inferiorly they are closer together than abactinally, and better developed. A tubercle at the ambitus has a disk-shaped scrobicule elevated above the mean height of the test; and ridges rounded and narrow, but long and shallow, in the form of costæ radiate from the base of the boss. One passes abactinally; and another actinally crosses the scrobicule, and reaches its margin, where it may unite with a corresponding one from the tubercles in vertical series; or it may unite with some confused costæ having large miliaries on them. On either side of the boss three or four costæ radiate laterally, one set, the longest, joining the costæ of the two tubercles of the neighbouring ambulacral plates, and the other, the shortest, pass to the poriferous zone close by. Each costa is perforated by a pair of pores. A few knobs or large miliaries are on the costæ here and there; and there are spaces between the costæ, large and oblique in the median area, and wide between each successive boss. The plain surface of the test is seen at the bottom. Near the actinostome the tubercles and costæ become rather crowded, and the spaces between the costæ simulate (but are not) pits in the test. The pores are in one series, and occupy but little space.

The interradial areas are wide, and have two vertical series of small perforate and crenulate tubercles rather widely apart. The tubercles are larger than those of the ambulacra, are largest at the ambitus, and are most crowded towards the peristome,

where they rapidly diminish in size. The costæ radiate from the base of the boss, cross the scrobicule, and have a miliary tubercle on them at the circle-edge. Three or four costæ placed close together in a band, unite the tubercles of the same vertical series, and two bands of two or three costæ, each ornamented with a miliary, pass off obliquely to unite with corresponding costæ from the two opposite tubercles. Four or five costæ pass to the poriferous zone, having miliaries here and there, and they join the perforated costæ of the ambulacra.

Other costæ occur in the intervals between all these and the bands, and thus a zigzag series of narrow, shallow, and broad spaces is produced. The peristome is very small, and the cuts also.

Height of the specimen $\frac{4}{10}$ inch, breadth $\frac{8}{10}$ inch.

Locality. North by east of Petiáni, west of Kotri, in the Ranikot series. Survey-number G $\frac{1}{3}\frac{2}{3}$.

Illustrations of the Species in Plate IX.

Fig. 6. *Arachniopleurus reticulatus*, Duncan and Sladen: natural size.

7. Part of an ambulacrum and interradium: magnified.

8. Some ridges near the apical disk: magnified.

Genus PROGONECHINUS, gen. nov.

Test of small size, moderately high, subconical above, concave beneath, margins tumid.

Poriferous zones straight, pores arranged in simple continuous series throughout. Ambulacral plates with three pairs of pores directly superposed. Interporiferous areas with two vertical series of primary tubercles placed marginal; additional primaries occurring on the plates near the ambitus; the rest of the plate occupied with granules. Interradial plates with groove-like slits at the inner extremity of the horizontal sutures. Interradial areas with two continuous vertical series of primary tubercles, the plates at the ambitus with two or more companion primaries in horizontal line, the vertical series of these being not continuous. The primary tubercles of both areas are neither crenulate nor perforate; those of the interradia are slightly longer than the ambulacral tubercles, and are sunken in deep scrobicules. Granulation coarse and unequal, with a tendency to become confluent around the tubercles. Some larger granules with mamelons. Apical system unknown.

Peristome subcircular, with rather deeply incised slits, with margins thickened and reverted.

1. *PROGONECHINUS EOCENICUS*, *Duncan & Sladen*. Plate X, Figs. 1-4.

The test is depressed, swollen at the ambitus, and sloping convexly to the apex. The actinal margin is rather pentagonal, the median interradial and ambulacral vertical lines are slightly depressed, and the spaces on either side are rather tumid. The extra

tumidity of the ambulacra produces the peculiar marginal outline. Below, the test is slightly concave.

Apical system wanting. The peristome is rather large, slightly pentagonal, and the cuts are distinct.

The ambulacra, about one half of the breadth of the interradial areas, have three pores in a slight depression arranged in simple vertical series, about four being in relation to an interradial plate. There are three poriferous plates to each whole compound ambulacral plate, and the sutures are very distinct. The adoral poriferous plate is short and band-like, extending the whole length of the ambulacral plate; the median plate tapers wedge-like inwardly, and is not more than two thirds of the breadth of the column; and the aboral poriferous plate is large, and might from its shape be compared to the primitive plate of an echinid ambulacrum. The plates are placed rather obliquely, and are more or less granular. Near the apex there is one small primary on each of the larger plates; near the ambitus there are two; and close to the actinostome there is but one, and it is larger there than elsewhere.

In the interradial areas the median depression is evident, and the broad and rather low coronal plates show sutural grooving, and near the angle the appearance of a slit-like pit.

At the ambitus the ornamentation consists of three small primaries or scrobicules surrounded by miliary granulation, which partly forms circles around the areas, and a confused intermediate ornamentation. Abactinally the number of primaries on each plate diminishes until only one is seen; and actually they also diminish in number, become larger until close to the peristome, and have distinct scrobicular circles. Extending from these larger primaries on the actinal surface to some small primaries near the pores are zigzag ridges.

The tubercles of the interradial plates have a flat boss and small mamelon, and are imperforate and non-crenulated. The cuts have a raised elongate ridge around them.

Height of the specimen $1\frac{3}{10}$ inch, breadth $1\frac{1}{10}$ inch.

Locality. Uncertain; but the colour and nature of the fossilization indicates the dark-brown Ranikot limestone. Survey-number G $1\frac{2}{3}$.

Illustrations of the Species in Plate X.

Fig. 1. *Progonechinus Eocenicus*, Duncan and Sladen: natural size.

2. Part of an ambulacrum and interradium near the ambitus: magnified.

3. Part of an interradial area near the actinostome: magnified.

4. Side view: natural size.

Remarks. This species is interesting as presenting a link between the Diadematidæ and Echinidæ (Triplechinidæ). The structure of the ambulacra is essentially that of the former group, whilst the tuberculation and general facies is very suggestive of some of the fossil forms of *Psammechinus*. Although the specimen under notice accords

closely with the generic formula of *Echinodiadema*; it differs greatly both in the form of the test and in the character of the tuberculation, and differs altogether in the presence of the *Salmacis*-like slits or grooves in the sutures of the interradian plates. This assemblage of characters readily distinguishes our form, and at the same time debars its admission to any known genus. It is to be hoped that further material will be forthcoming to enable a more complete diagnosis to be drawn up.

Subfamily *ECHINIDÆ*.

Section POLYPORI.

A fragment of a large regular Echinid of the Polypore type, with a stout test, has nine interradian plates from the apex downwards preserved; a corresponding space of an ambulacrum exists, as well as part of another interradium.

Genus *EURYPNEUSTES*, gen. nov.

Test of large size, probably subconoid or subdepressed, not tumid.

Ambulacral areas very broad, rather narrower than the interambulacral opposite the tenth plate. Poriferous zones very wide, about one fifth of the breadth of the interambulacral area. Pores arranged in three vertical series; five or six poriferous plates comprised in each whole compound ambulacral plate; the pairs of pores borne on each are disposed in the zone according to the following order: two or three consecutive pairs of pores form a slightly oblique arc at the outer margin of the zone; the pair borne on the next more aboral poriferous plate stands in the middle of the zone; and the pairs borne on the succeeding two plates are placed in slightly oblique sequence on the inner margin of the zone. The outer vertical series thus consists of slightly oblique arcs of two or of three pairs; the median series, which is somewhat irregular, of single pairs, widely spaced in vertical sequence; and the inner vertical series of two pairs of pores, which stand to one another in oblique succession. A straight and regular, vertical line of primary tubercles stands at the extreme margin of the interporiferous area on either side; one primary is on each plate, the intermediate space being occupied by a number of very small widely spaced secondary tubercles and miliary granules.

Interambulacral areas with two continuous vertical series of primary tubercles similar to, and only slightly larger than, the ambulacral tubercles, placed nearer to the poriferous zone than the middle of the plate; near the ambitus a second and more outward tubercle is present. The inner portion of the plate is occupied by very small secondaries and miliaries.

In consequence of the wide and trilinearly arranged poriferous zones, this genus presents a closer superficial resemblance to *Hæpponœ*, Gray (*Tripneustes*, Agassiz), than to any other of the Polyperi. In structural detail, however, it is widely separate, and is readily distinguished from any of the known forms by the crenulate tubercles, the number and arrangement of the pores and poriferous plates, and the character of the ornamentation.

1. *EURYPNEUSTES GRANDIS*, sp. nov. Plate VIII, Figs. 4, 5.

The ambulacrum is very wide, but near the ambitus it has not quite the breadth of the interradium there. The poriferous zone is very wide, but it does not equal the interporiferous area in breadth at a slight distance from the apex. The poriferous zones are nearly on a level with the rest of the test, being very slightly depressed; they are narrow towards the apex, but they soon enlarge, and then remain at very much the same breadth. The series of pores are not crowded except near the apex, where there is a simple succession opposite the first interradial plate; lower down there is crowding, and some pores are out of the straight line. The third interradial plate (and three below it) has in relation to it two distinct series of pores, an outer and inner, and an indefinite middle series. There is thus a vertical series of pairs of pores on either side of the poriferous zone, and a more incomplete one, with intervals here and there, in the middle part of the zone. Really, at the ambitus, there are two vertical series of triple pairs, one pair often being in the middle of the zone. Near the ambitus there are usually six poriferous plates to each whole composite ambulacral plate; but on the upper portion of the area, and also here and there elsewhere, one of the poriferous plates is wanting, and the regular sequence of two sets of triple pairs is destroyed. The pores are large and nearly circular in outline, and the three and two pairs are close, in vertical succession; but there is some space between the series in all directions.

The ornamentation of the poriferous zone is scanty; there are a few small tubercles, with slightly crenulated processes, and they are placed in twos or threes obliquely between the succession of the central series of pores. Usually the tubercles are of three sizes, the smallest being nearest the inner row of pores. Many sharply pointed miliaries exist on the ridges between the pores, and are oblong or in linear series.

The miliaries in linear series are very small, and follow the lines of the junction of the poriferous plates.

The interporiferous zone is narrow towards the apex, and it soon widens, so that at the level of the tenth interradial plate it is nearly twice the width of the poriferous zone. The plates are double the number of those of the interradial area, and each one carries, near the poriferous zone, a primary tubercle, imperforate and crenulated. These tubercles are smaller than the primaries of the interradial area, and increase in size from above downwards. They are in vertical series, and are well apart; and the surface of the test between the tubercles is plain. The remainder of the plate has a few very small and faintly crenulated secondary tubercles on it, and a few miliaries. The number of these small tubercles increases towards the ambitus, and seven or eight are noticed on the largest plates.

The interradial area has the plates slightly convex from side to side, and the sutures very distinctly marked. One vertical row of large crenulated, imperforate tubercles is on the ambulacral side of the plate, and a second and slightly smaller row is commenced at the sixth plate from the apex. The tubercles have broad bosses arising

from a very faintly marked scrobicule environed more or less distinctly by a few wide-apart miliaries. The boss is tumid, and the crenulation passes down the flanks; the mamelon is small. The number of the large tubercles in vertical series, in relation to that of the ambulacral series, is one half; and the interrarial ones are at least one third larger than the others. As the vertical series passes downwards it is placed nearer the centre of the plate in order to permit the second series to come in. In the higher plates, from the fifth towards the poriferous zone, there are a few small, crenulate, imperforate tubercles; they are represented by large miliaries nearer the apex, and by larger tubercles lower down. Towards the median line of the interrarial area no large tubercles exist, but there are several crenulate and imperforate ones about the size of the boss of the larger tubercles, and they are scattered without order.

Here and there are some small miliaries. Hence there is much median space, without any large tuberculation, on the upper part of the test.

The breadth of the largest interrarial plate is $\frac{1}{2}$ inch, and the breadth of the ambulacrum at the same level is $\frac{7}{8}$ inch.

Locality. North by east of Petiáni, west of Kotri. Ranikot series. Survey-number G $\frac{289}{185}$.

Illustrations of the Species in Plate VIII. •

Fig. 4. The specimen of *Eurypneustes grandis*, Duncan and Sladen: natural size.

5. The tenth interrarial plates and corresponding ambulacral plates: magnified 3 times.

A large portion of the test of one of the regular Echini is in the collection from the Ranikot series. The actinal surface of the test is partly preserved, but only a small portion of the peristome is visible; the ambitus is defective, and there are parts of the ambulacra and interrarial series above it in a bad state of preservation. The apical system is absent. The general shape has been preserved.

The details of the test indicate that it belongs to a genus not hitherto noticed, and they are described with the hope that, on some future occasion, more perfect specimens may be found.

•
Genus ÆOLOPNEUSTES, gen. nov.

Test of large size, subcircular or subpentagonal in marginal contour, subdepressed and subconical abactinally. Sides tumid.

Ambulacra broad, narrower than the interrarial areas. Poriferous zone wide, equal to or greater than half the breadth of the interporiferous area; both zones broadest just above the ambitus, and decrease gradually towards the peristome. The pores on the abactinal portion of the zone are arranged in almost horizontal arcs of five or six pairs, very regular and very closely placed; below the ambitus on the actinal surface the number of pairs of pores in each arc diminishes, the arc straightens, and the angle of obliquity decreases, by gradual stages, until close to the peristome the pairs of pores stand in almost straight and simple vertical series.

In the interporiferous areas on the actinal surface there is a straight vertical series of primary tubercles, crenulate and imperforate, placed on each margin, and here and there a companion tubercle of similar size placed on the inner part of the plate; ordinarily, however, this part of the plate is occupied only with a few small and widely spread miliaries. It is impossible to state accurately the disposition of the tubercles above the ambitus.

The plates of the interambulacral area are very broad and short; in the actinal portion there are two continuous vertical series of primary tubercles, placed rather nearer to the poriferous zone than the middle of their respective plate. Near the ambitus there may be one or even two similar tubercles on either side of the central primary, standing in a horizontal line, the number of tubercles decreasing towards the peristome.

The ornamentation of the abactinal portion of the area is undistinguishable; but it is probable that the inner half of the plate was occupied only by rather widely spaced miliary granulation. The primary tubercles of both areas are small and uniform in size.

Peristome small and more or less sunken, with narrow and deeply-indented mouth-slits.

1. *ÆOLOPNEUSTES* DE LORIOLI, sp. nov. Plate VIII, Figs. 6-9.

The test is thin, pentagonal in marginal outline, tumid at the ambitus, and slopes thence gradually to a narrow apex. The actinal surface is generally flat, but there is a slight convexity about it, and the moderately sized peristome is decidedly sunken.

The breadth of the test is nearly double the height; the ambulacra are slightly more prominent above the ambitus than the interradial areas, which have a strongly marked median depression; and the primary tubercles are small and equal throughout, few in number, imperforate and crenulate.

The pores are in simple series near the peristome, but increase in number in relation to the interradial plates, towards the ambitus, and on the upper part of the test, where they are in several series of arcs in a broad zone.

The apical system is wanting in the specimen.

The ambulacra are broad, more than one half the width of the interradial areas just above the ambitus, and then contract gradually towards the peristome. The poriferous zones are wide, being, above the ambitus, equal to or even more than half the breadth of the interporiferous area, narrowing greatly towards the peristome. The pores on the abactinal portion of the zone are arranged in almost horizontal arcs of five or six pairs, very regular and very closely placed. Just below the ambitus on the actinal surface the number of pores in each arc is six, and the angle of obliquity about 45° ; rather nearer the peristome the number is reduced to five; and about midway between the ambitus and the peristome there are only four, and these are arranged in slightly oblique lines instead of arcs; the number is then reduced to three, and the obliquity becomes still less, until close to the peristome the pairs of pores stand in almost straight and

simple vertical series. The pores are round, conjugate, close; and close above and below, the pairs being separated by a ridge with a very small tubercle upon it. The composition of the ambulacral plate is interesting. The lowest or most adoral of its poriferous plates usually extends the whole breadth of the ambulacral plate, as a band-like strip of uniform thickness; the next pair of pores is borne on the primary ambulacral plate; and the succeeding poriferous plates are small wedge-like plates for the reception of which the primary ambulacral plate has its aboral and outer margin scooped away, the aboralmost of these small plates not being more than one half the breadth of the ambulacral plate, the intermediate ones smaller still.

The ornamentation of the interporiferous zone is simple: there is a small primary tubercle on each plate, placed nearer the poriferous zone than the median sutural line from the actinostome to near, or midway to, the margin, where a second tubercle is seen on two or three plates. The tubercles are small, nearly equal, and crenulate, and their bases are flush with the test. A few very small tubercles, larger than miliaries, are scattered without much order on the plates near the margin, and are still nearer the peristome.

The interrarial areas are occupied by numerous low and broad plates, larger than those of the ambulacra; the median suture is well developed, and the other sutures also, and they indicate some curving of the upper and lower margins of the plates. The tubercles are small on the plates, equal to, if not slightly larger than those of the ambulacra. On the actinal surface there is one primary tubercle on each plate near the peristome; a little further out there are two, and nearer the margin three, and finally four to a plate. There are two vertical rows, which reach to the peristome on each interrarial area; and then further out there are rows corresponding with the increase in number of the tubercles. There are a few very small tubercles, and some miliaries slightly smaller on the plates, and they are sparsely placed in more or less concentric rows around the larger tubercles.

Above the margin the number of larger tubercles can be estimated in spite of the worn condition of the test, and two on each plate appears to be the number. The smaller tubercles are larger there than on the actinal surface, and surround the larger ones in a scrobicular circle, giving a granulated appearance.

The cuts for the branchiæ are well developed.

The length of the test is nearly $1\frac{2}{10}$ inch, and the breadth is $2\frac{2}{10}$ inch.

Locality. Ranikot series, north by east of Petiáni, west of Kotri. Survey-number G $\frac{89}{35}$.

Illustrations of the Species in Plate VIII.

Fig. 6. The outline of the test: natural size.

7. The actinal surface: natural size.

8. A part of the actinal surface: magnified.

9. The cuts and the ambulacrum near the peristome.

Spines of Cidaridæ. Plates X. & XI.

Numerous spines of species of the genera *Cidaris*, *Phyllacanthus* (*Rhabdocidaris*), and *Porocidaris* are in the collection of Echinoidea from the Ranikot series of Sind.

SPINES OF SPECIES OF CIDARIS.

In Plate X. the figures 9 and 10 represent a long tapering spine with a slightly compressed outline, a plain surface for a short distance above the projecting ring above the base of the shaft, and longitudinal rows of small, close, bluntly serrate knobs along the shaft reaching from the plain surface to the tip.

A larger and more coarsely ornamented spine, with incisions on the ring around the hollow for the tubercle, is drawn at figures 11 & 12.

A thin, small, and almost plain spine with the milled ring slightly crenulate, on one side, is drawn on figures 13 & 14.

The locality whence these spines were derived was north by east of Petiáni, west of Kotri, in the Ranikot series. Survey-number G $\frac{280}{135}$.

The broader, stouter, more fusiform, and more roughly granular and spinulose spines, with slightly triangular and compressed sections, figured on Plate XI. figs. 1-11, are probably those of species of *Cidaris*.

Locality. Hills east of Lynyan, Ranikot series. Survey-number G $\frac{280}{120}$.

A *Porocidaris* spine of great interest is figured on Plate XI. Figure 12. The spine fractured, natural size, and its section. Figure 13. The same, magnified.

This spine is greatly compressed above the cylindrical base, which has a crenulate ring below the shaft, and also a crenulate ring around the cavity for the tubercle.

The shaft has a broad central part, from the sides of which numerous stout processes project obliquely upwards. The front of the flattened shaft has a longitudinally striated ridge; and the back is slightly convex and striated. The raised striæ pass off into the lateral processes.

Locality. Makli Hill scarp, near Tatta, Ranikot series. Survey-number G $\frac{280}{108}$.

Numerous large, much flattened, broad spines, with small crenulate rings, belong to the genus *Phyllacanthus* (*Rhabdocidaris*, Desor). The flat surfaces are ornamented with numerous blunt serrations; and these are largest at the sides, from which some project considerably. Plate XI. figs. 14-23.

Locality. Hills east of Lynyan, Ranikot series. Survey-number G $\frac{280}{127}$.

Order **ECHINOIDEA EXOCYCLICA.**

Suborder GNATHOSTOMATA.

Family *CONOCLYPEIDÆ*.Genus *CONOCLYPEUS*, *Agassiz*, 1840 (amended).

Large Urchins, more or less oval or elliptical in marginal outline, conical, vaulted swollen or subconical above, rather flat actinally, and with a thick test. Apical system button-shaped and projecting; ocular plates very small. Ambulacra very long, straight, not tending to close; poriferous zones broad, conjugate; grooves well developed; interporiferous zone large. Peristome central, with well developed tumid bourrelets, and without a phyllode. Jaws exist, and auricles also. Periproct inframarginal or marginal, oval and longitudinal. Ornamentation small, very equal, of sunken scrobicules surrounding small tubercles, with a mamelon which is perforate and crenulate, and separated by a raised surface minutely granular.

1. *CONOCLYPEUS SINDENSIS*, sp. nov. Plate XII, Figs. 1-4.

The test is very thick, elliptical in marginal outline, subconical, broader than high, longer than broad, more tumid anteriorly than posteriorly (above the swollen ambitus), and sloping more suddenly anteriorly than posteriorly. The transverse section in a line with the apical system, which is excentric in front, is nearly hemispherical above. In the longitudinal section, the posterior slope from the apical system is at first rather sharply impressed, then curved outward somewhat tumidly at about two thirds the distance from the apex to the posterior extremity, and thence slopes down rather rapidly to the margin. The actinal surface is slightly tumid, and slopes to the margin and to the central peristome. Apical system defective, but was small.

The ambulacra are long and unequal. The odd and the anterior pair are straight; and the posterior pair, which are the longest, are gracefully curved, being bowed out laterally at their upper third conformably with the incurved or impressed portion of the odd interradium. They do not come very close to the margin, and are widely open at the extremity.

The poriferous zones are broad; the pairs of pores are numerous, the grooves between them well pronounced, and the raised intermediate ridges have one row of well-developed granules. In the anterior odd ambulacrum the poriferous zone is broader than the interporiferous area, except in the actinal third, where this last region is slightly the broadest. But in the posterior ambulacra, at the lower end of the upper third the interporiferous zone is equal in breadth to one of the poriferous zones. The inner pore is larger than the outer.

At the actinal termination of the ambulacra, and above the margin, the poriferous

zones suddenly diminish in breadth, and the direction of the pores becomes oblique, and that of the grooves also; so that whilst the direction of the inner pores is nearly in the line of the series, that of the outer set describes about one quarter of a circle. A single row of pores is continued from each zone over the ambitus to the peristome, where the direction becomes slightly irregular and alternate; but there is no doubling there, nor is there a true phylloids. The interambulacra are swollen and somewhat boldly convex close to the apex; and they are more rounded and tumid midway to the ambitus.

The peristome is central, large, deep, transversely elongate; and the projecting, rounded, and bluntly pointed bourrelets have grooves between them for the gutter-shaped ends of the ambulacra.

The ornamentation is slightly largest actinally, and it decreases towards the ambitus. It is subequal and small on the apical part of the test, and everywhere consists of a raised interscrobicular granular part and sunken scrobicules with small tubercles consisting of a boss and small mamelon, which are not higher than the ordinary level of the test. Traces of crenulation are seen here and there; and the minute mamelon is perforate.

The periproct is inframarginal and elongate longitudinally, and it transgresses slightly on the margin, which is less tumid posteriorly.

Height of the test at the apex $2\frac{1}{10}$ inches, breadth 4 inches, length $4\frac{6}{10}$ inches.

Locality. North-east of Petiáni, west of Kotri. Ranikot series. Survey-number

$\frac{280}{135}$.

Illustrations of the Species in Plate XII.

- Fig. 1. The actinal surface of the test: natural size.
2. An end of an ambulacrum: slightly magnified.
3. The ornamentation: magnified.
4. Part of an ambulacrum, high up: magnified.

2. CONOCLYPEUS?, sp. Plate XII, Figs. 5, 6.

There is a specimen from the hills east of Lymnæ, from the brown Ranikot limestone, which is so much worn that its specific diagnosis is not possible, and the generic is also doubtful.

The marginal outline is oval and broadest posteriorly; and the periproct is oval, pointed in front, longitudinal, and transgresses on the margin. The ambitus is tumid, and the abactinal surface is conical, the height being less than the breadth. The ambulacra come rather close to the margin, are widely open; and the poriferous zones are not very broad, and end in a point. The apex appears to have been central and the ornamentation small.

Probably it is a species of *Conoclypeus*; but the actinal surface is not visible.

Height of specimen $2\frac{1}{10}$ inches, breadth $3\frac{7}{10}$ inches, length $4\frac{3}{10}$ inches.

Survey-number G $\frac{280}{127}$.

Illustrations of the Specimen in Plate XII.

Fig. 5. Side view : natural size.

6. The periproct : natural size.

3. *CONOCLYPEUS DECLIVIS*, sp. nov. Plate XII, Fig. 7.

Another specimen, probably of a species of *Conoclypeus*, is much broken and covered with brown limestone. It is oval, but is broadest in front and narrower, decidedly, behind; the margin is sharp, and the test slopes up to the apex, which is slightly excentric and in front not with a convex tumidity, but with here and there concave surfaces, becoming convex close to the apex. The ambulacra are unequal, the posterior being the longest, and they come down rather close to the margin; they are widely open, and the interporiferous zone is broader than a poriferous, nearly throughout. The poriferous zones are not very wide, end in a point, and the ridges between the conjugate pores are multigranular. The ornamentation of the interporiferous zone is of numerous sunken scrobicules, with intermediate granulation, and the bosses are small and with small mamelons. The interambulacra differ in size on account of the comparative closeness of the anterior and the antero-lateral ambulacra, and their shape gives a pinched-up appearance to the apical part of the test. The actinal part is invisible. The ornamentation is larger and scantier than in the forms already noticed.

Locality. East of Lynyan, Ranikot group. Survey-number G 139.

Illustration of the Species in Plate XII.

Fig. 7. The test: natural size.

Suborder ATELOSTOMATA.*Family* CASSIDULIDÆ.*Subfamily* ECHINOLAMPINÆ.*Genus* PHYLLOCLYPEUS.

Phylloclypeus, de Lorient, 1881, *Monographie des Echinides contenus dans les couches Nummulitiques de l'Egypte*, p. 79.

In true species of *Conoclypeus* the bourrelets around a more or less circular peristome are very large and equal, and the phyllodes have neither intercalated plates nor doubling of the ambulacral pores. In *Phylloclypeus* the bourrelets are not very large, are unequal, and surround a more or less pentagonal peristome. The phyllodes have intercalated plates and double pores, so that the floscelle is well developed. Some species of *Echinolampas* only differ from *Phylloclypeus* by having unequal poriferous zones; and it is advisable either to place *Phylloclypeus* as a subgenus of *Echinolampas*, or as a genus of Echinolampinæ as a subfamily. Certainly *Phylloclypeus* has no jaws.

1. ? *PHYLLOCLYPEUS*, sp. Plate XII, Fig. 8.

A very fragmentary specimen of a large Echinoid is from the gypseous shales from the hills east of Lynyan in the Ranikot series.

The marginal outline is oval and broadest in front, the margins are slightly tumid, and the upper part is rather low and conical, the sides being convex. The apex is nearly central. The remnants of the ambulacra show that they were widely open, the poriferous zones being moderately broad, ending in a point close to the margin. The ridges, between the conjugate pores, are coarsely granular (one row), and the poriferous zone is narrower than the interporiferous area.

The most interesting part of the test is around the peristome, where a phyllode is preserved. The pores are evidently doubled in several instances, and the bourrelets do not appear to have been large.

There is then some doubt about this specimen belonging to the *Conoclypeidæ*, and we are disposed to place it with de Loriol's genus *Phylloclypeus*.

Height of specimen 2 inches; breadth $3\frac{1}{8}$ inches; length $4\frac{1}{2}$ inches.

Survey-number G $\frac{280}{120}$.

Illustration of the Species in Plate XII.

" Fig. 8. The phyllode: magnified.

Genus PLESIOLAMPAS.

Plesiolampas, Duncan & Sladen, *Foss. Echin. of Sind, Pal. Indica*, series xiv. p. 9 (1882).

1. *PLESIOLAMPAS PLACENTA*, sp. nov. Plate XIII, Figs. 4-9, and Plate XIV, Fig. 1.

The test is considerably depressed, slightly longer than broad, with a squarely oval marginal outline. Abactinally the slope from the, slightly eccentric in front, apical system is not quite so decided anteriorly as posteriorly; the margins are tumid, and in front more so than behind, where there is no rostration. Actinally the peristome is deeply seated in a concavity and is slightly in front of the centre, and the test is swollen around it to the margins, but less so posteriorly. The periproct is entirely inframarginal, reaches close to the edge, and is elongate oval.

The apical system is small and compact, the madreporic body is central and minutely granular on the surface. There are four generative pores, and the front pair are closer together than the hind ones. The ocular plates and pores are small.

The ambulacra are subequal, the posterior being the longest, rather wide, slightly petaloid, widely open, and extend to a short distance from the margin. The interporiferous zones are broad, slightly raised, and are widest about midway, and the poriferous zones of each ambulacrum are equal; the pairs of pores are numerous, oblique, conjugate, the outer pore being elongate and the inner subcircular, and the costal ridges have a row of minute granules on them.

Beyond the petaloid portion the ambulacra expand over the margin and contract close to the peristome. A single series of pores is continued as the prolongation of a poriferous zone, and the pores are close and numerous at the margin and as far as the peristome, the plates being broad but low. At the peristome the ambulacra narrow inwards, and have no doubling of the pores, but a slight departure from the serial lines, and within the peristome there are two pores close together. The ornamentation of the interporiferous zones is of sparsely distributed sunken scrobicules with a small boss, the intermediate parts being minutely granular. This ornamentation is closer at the margin and larger actinally, and it becomes scantier at the low gutter-shaped area of the ambulacra between the rudimentary bulging bourrelets. There is no true phyllode. In one specimen there is an appearance of a double row of pores, but the inner rows of pores do not penetrate, are more or less aborted, and each is overarched by a prominence developed on the next aboral plate; they appear to be depressions for sphæridia (Plate XIV. fig. 1).

The interradian areas are narrow at the apex; and the ornamentation of the abactinal part is of the same character as that of the interporiferous zones, but is scantier; and the granulation is more distinct, and it is closest and smallest at the margin, and largest and scantiest actinally.

The peristomial continuations of the interambulacra are slightly tumid, pass upwards between the ambulacra there, and are covered with a minute crowded ornamentation of small bosses; they constitute rudimentary bourrelets. The peristome is transversely elongated, open, pentagonal, and the bounding lines are convex and tumid inwards. Posteriorly, from the peristome to the periproct, is a median line of crowded minute granules, a few sunken scrobicules and bosses being along it here and there. The periproct is long, but distant from the peristome by more than its own length, is close to the margin, is broadest posteriorly, and is surrounded by a crowded ornamentation.

There is some variation in the shape of the specimens of this species, and it mainly relates to the position of the greatest breadth.

Height of specimen.	Breadth.	Length.
$2\frac{7}{10}$ inch.	$2\frac{1}{10}$ inch.	$2\frac{3}{10}$ inch.
$\frac{6}{10}$ "	$1\frac{9}{10}$ "	$2\frac{1}{10}$ " (Fig. 4).
$\frac{5}{10}$ "	$1\frac{7}{10}$ "	$1\frac{9}{10}$ " (Fig. 5).
$\frac{5}{10}$ "	$1\frac{6}{10}$ "	$1\frac{8}{10}$ "

Localities. Ranikot series, Jhirak, north-east of Petiáni, west of Kotri. Survey-numbers G $\frac{289}{124}$, G $\frac{289}{135}$, G $\frac{226}{164}$.

Illustrations of the Species in Plates XIII & XIV.

Plate XIII.

Fig. 4. The test, from below.

- Fig. 5. Another specimen ; the test, from above.
 6. Part of an ambulacrum : magnified.
 7. The peristome : magnified.
 8. The peristome : more highly magnified.
 9. The longitudinal outline of the test.

Plate XIV.

Fig. 1. The rudimentary phyllode : magnified.

2. *PLESIOLAMPAS PRÆLONGA*, sp. nov. Plate XIV, Figs. 2, 3.

The test is elongate, the length in proportion to the breadth as 7 : 5, subdepressed and convex above, very tumid at the sides and in front, subrostrate posteriorly. Marginal contour elliptical, widest posteriorly opposite the extremities of the posterior petals, and then contracting somewhat rapidly to the posterior point; anterior to the widest part the outline is almost paraboloid. Actinal surface very tumid, with the peristome deeply impressed and the tumidity of the test slightly less in the posterior median line than elsewhere. The longitudinal profile shows the abactinal surface of the test to be very level, passing down with rather a rapid but well-rounded curve along the posterior rostration. The transverse profile presents rather a flatly convex outline, tumid at the sides, and bending round onto the actinal surface with an uninterrupted curve.

The apical system is small and excentric in front, its distance from the anterior extremity being little more than one third of the length of the test. There are four generative pores, the posterior pair larger and slightly wider apart than the anterior pair, and with two rather conspicuous small tubercles, similar to those which ornament the test, standing in a line drawn between the posterior pores. The madreporic body occupies the central space, and is prominently convex.

Ambulacra small, distinctly petaloid, converging towards their outward extremities; the antero-lateral petals terminating at a distance from the margin equal to one third of the length of the petal, whilst the posterior pair terminate at fully their own length distance from the margin. The petals of the paired ambulacra are of equal width, but the posterior pair are slightly longer than the anterior. The posterior poriferous zone of the antero-lateral ambulacra is somewhat longer by 2 or 3 pairs of pores, and more curved than the anterior zone; in the posterior petals, the curvature of the zones is equal, and their length does not differ by more than one pair of pores. The odd ambulacrum is covered by matrix. The anterior pair form a wide angle with one another, and the posterior pair a much smaller one.

The poriferous zones are narrow and slightly broadest at the middle of the zone, their width here, however, being less than one half the breadth of the interporiferous area. The inner pores are round, and the outer slightly elongate transversely; and they are united by a faint conjunctive furrow, the costal ridges that separate the pairs of pores being ornamented with a single line of minute uniform granules, five or six in number at the broadest part of the zone. In the antero-lateral ambulacra there are 29

or 30 pairs of pores in the anterior zone, and 32 in the posterior; and there are 38 or 39 pairs of pores in the zones of the postero-lateral ambulacra. The extrapetalous continuation of the zones consists of single pores, rather widely spaced, in consequence of the height of the extrapetalous ambulacral plates. Close to the peristome the pores are nearer together, and there is some irregularity in their serial arrangement, and two or three supplementary pores are present, thus forming a very indistinct and rudimentary phyllode. The interporiferous areas are flush with the surface of the test, but appear very faintly convex in consequence of the slight depression of the poriferous zones. The postero-lateral interrarial areas are slightly prominent close to the apical disk.

The ornamentation of the interrarial areas and that of the poriferous zones are similar, and consist of very small tubercles equidistantly spaced, and sunken in deep scrobicules, the intermediate space being granular and with a tendency to become confluent immediately round the scrobicule, the intermediate granules remaining more distinct. On the abactinal portion of the test the intermediate granular spaces are usually greater than the breadth of the scrobicules. In the interporiferous areas the tubercles are slightly smaller and more crowded, and also just below the ambitus. On the actinal surface the tubercles are larger than elsewhere, the scrobicules wider, and the intermediate space is reduced to seldom more than a single granular ring, and which becomes more or less confluent. There is an indistinctly defined, subconfluently granular, median band, devoid of tubercles, extending between the peristome and the periproct.

The peristome is large, slightly excentric in front, and more central than the apical system, transversely elliptical, the breadth being $\frac{1}{5}$ inch, and the shorter diameter $\frac{1}{4}$ inch, with the lateral apses acutely angular. The peristomial wall is closely granular, and there is no development of bourrelets. The terminal portions of the ambulacral areas which form the incipient phyllodes are very faintly sunken.

The periproct is large, elliptical, placed longitudinally and inframarginal, sloping up slightly from the actinal surface, and overarched by the posterior rostration of the odd interradium. The length is $\frac{5}{20}$ inch, and the breadth $\frac{2}{20}$ inch.

Dimensions. Length of the specimen $1\frac{4}{10}$ inch, breadth 1 inch, height $\frac{11}{20}$ inch.

Distance of apical system from posterior edge $\frac{9}{10}$ inch.

Locality. East of Kandaira in the Vero plain, Ranikot series. Survey-number G $2\frac{2}{3}$.

Remarks. This is more nearly related to *Plesiolarpas elongata*, Duncan and Sladen*, than to any other member of the genus. It is distinguished from that form by the more elongate and anteriorly more contracted test, by its more level abactinal surface and less gibbous posterior rostration, by its much wider, more petaloid, more highly developed, and differently proportioned ambulacra, by its more actinally placed periproct, and finally by its more widely spaced tuberculation. Though thus well marked specifically, there is no doubt of this form being the representative of the Infra-Trap species in the Ranikot strata.

Illustrations of the Species in Plate XIII.

Fig. 2. Actinal aspect of the test: natural size.

3. Apical disk and part of the surrounding portion of the abactinal surface: magnified.

Also a portion of the poriferous zone: more highly magnified.

Numerous specimens of a *Plesiolampas* from $\frac{3}{10}$ inch to nearly $1\frac{1}{2}$ inch in length were found at a spot north by east of Petiáni, west of Kotri; on hills east of Lynyan, from the brown limestone and gypseous shales, in the Ranikot series.

Every stage of growth from a minute globular and slightly elongate form to a depressed ovoid (the adult shape) is represented in the series of specimens; and in all there is a large, open, transverse, elliptical peristome, a large ovoid periproct placed longitudinally, marginally, or submarginally, and short, open ambulacra placed eccentrically in front of the centre. The floscelle is feebly developed. The adult form may be taken as the type.

3. *Plesiolampas ovalis*, sp. nov. Plate XIV, Figs. 4-18.

The test is moderately thick in substance; and its marginal outline is ovoid, with a slight enlargement behind the centre on either side, and a slight blunt point where it is narrowest behind.

Above, the shape is slightly convex, and rather flat at the vertex and median line; the margins are well rounded, especially anteriorly. The highest point is rather behind the centre of the upper part, but the slope is very gradual from it. Beneath, the surface is slightly concave, especially near the peristome.

The apical system is eccentric and in front of the centre; the generative pores are four in number, and surround a well-developed, convex, madreporic body. The ambulacra are subpetaloid, are open at the end, and show but a slight disposition to close; and the perfect poriferous zones end far from the margin. The anterior ambulacrum is the shortest and usually the narrowest; it is widely open anteriorly, has a narrow interporiferous zone, and equally developed poriferous zones. The pores, as in the zones of all the ambulacra, are conjugate; the outer series are the largest, and are round in worn specimens, rather elongate when well preserved. The inner are smaller and rounder. This ambulacrum, like the others, is very slightly raised above the level of the test, and its zones are of equal length, or one may have one pair of pores more than the other.

The ocular pore, as is the case in the other ambulacra, is small, and the first three or four pairs of pores are exceedingly small and close, so that a small space exists around the apical disk, where, in all the ambulacra, there appears a defective poriferous development. The pores become fully developed in all the ambulacra in about one quarter the length of the zones.

The antero-lateral ambulacra form the sides of a very open angle; they are more petaloid than the others, and their interporiferous zones are the largest. They are shorter than the posterior ambulacra, which are open and form an acute angle, and terminate far from the end of the test.

A line of single pores passes from the *inner* set of each poriferous zone over the margin, including a space which extends close beyond the end of the petals and contracts towards the peristome, where there is a slight flaring and apparent doubling of a few pores. The poriferous zones are rarely unequal, and then only in a slight degree.

The peristome is less excentric than the apical system, is large, open, transverse, elliptical, with the front rather sharply curved, and broadest from side to side. The interambulacral portions of the mouth are nearly vertical and are profusely granular, and there is a faint broad bourrelet-ridge. The phyllodes are small, but there is a doubling of pores, and two pores are seen within the peristome.

A band of miliaries with traces of zigzag lines, more or less worn, exist between the peristome and the periproct, which in large specimens is inframarginal or slightly obliquely placed in the margin itself. It is large, ovoid, widely open, and the length is longitudinal. It is close to or at the margin, and has a point or rudimentary rostrum overhanging it above.

The ornamentation of the upper part of the test is of small tubercles with distinct scrobicules; and the raised surface between them is minutely granular, with microscopic miliaries. The same ornamentation is on the interporiferous zones. The interambulacra are slightly raised between the petals and close to the apical system. The tubercles are larger actinally and less crowded there. •

Length of largest specimens rather more than $1\frac{4}{10}$ inch, breadth $1\frac{1}{10}$ inch, height $\frac{9}{10}$ inch.

Locality. North by east of Petiáni, west of Kotri. Survey-number G $\frac{280}{124}$. Jhirak, and hills east of Lynyan. Survey-number G $\frac{230}{126}$.

Other specimens:—

Length $1\frac{3}{10}$ inch, breadth 1 inch, height $\frac{5}{10}$ inch. In specimens of this length the posterior projection is very evident, and the periproct is oblique on the margin, ovoid, large, open, and longitudinal in its great axial direction.

Smaller specimens $1\frac{1}{10}$ inch in length, are $\frac{9}{10}$ inch broad, and rather over $\frac{4}{10}$ inch in height.

Locality. East of Kandaira, on the Vero plain. Survey-number G $\frac{230}{133}$.

Another, 1 inch long, is $\frac{8}{10}$ inch broad and nearly $\frac{5}{10}$ inch high.

Locality. Hills east of Lynyan. Survey-number G $\frac{280}{135}$.

Its periproct is inframarginal and very slightly transgressive.

A smaller, $\frac{9}{10}$ inch long, is $\frac{7}{10}$ inch broad and $\frac{4}{10}$ inch high. A second, $\frac{8}{10}$ inch long and $\frac{6}{10}$ inch broad, is $\frac{4}{10}$ inch high, and the mouth is more central, and the huge longitudinal periproct is oblique on the margin and rostrated.

One, $\frac{7}{10}$ inch long, rather over $\frac{5}{10}$ inch broad, is just under $\frac{4}{10}$ inch in height.

Other measurements are:—

Length	$\frac{6}{10}$,	breadth	$\frac{5}{10}$,	height	$\frac{3}{10}$ inch.
	$\frac{5}{10}$,	„	$\frac{4}{10}$,	„	$\frac{3}{10}$
	$\frac{4}{10}$,	„	$\frac{3}{10}$,	„	$\frac{5}{20}$
	$\frac{3}{10}$,	„	$\frac{2}{10}$,	„	$\frac{2}{10}$

Remarks. The worn specimens of the larger types give a fallacious idea of the poriferous zones; for when well preserved they are traversed by a succession of bars between the pairs of pores, and they are covered with a row of miliaries. The linear nature of the pores is then shown and their conjugate nature.

The petals never reach the margin; and their inequality is very slight, and never amounts to that of the typical Echinolampidæ described by MM. d'Archiac and Haime. The miliary median space inferiorly and the shape and position of the periproct are worthy of notice.

Premature Forms. The examination of the young forms gives some very interesting results.

The shape of the young forms is higher, more tumid, convex at the top, elongate; and the periproct is large and obliquely placed on the posterior margin, and invading the under surface also. It is longitudinal and oval. The peristome is large and sub-central.

The poriferous zones in the very small forms are not developed near the ocular pores, but they are further out. They are sensibly unequal, short, and the whole rosette is anterior and small. The deficiency of pores in the anterior ambulacrum is remarkable in some specimens.

The next group, in point of size, show increasing elongation of the test, and the unequal condition of the poriferous zone is palpable. All this is seen in specimens $\frac{1}{2}$ inch in length, and in others in a less degree up to $\frac{3}{4}$ inch. The test is then flatter, but the large periproct and peristome are rather close together, the former transgressing on the lower surface. The unequal pore-zones are not so definite. In some there is a slight difference in the size of the poriferous zones in the same petal.

Illustrations of the Species in Plate XIV.

- Fig. 4. The actinal aspect: natural size.
 5. Portion of the median granular band and periproct: magnified.
 6. Outline of the longitudinal profile of the test.
 7. Abactinal view of another specimen.
 8. Apical disk and portion of abactinal surface of another specimen: magnified.
 9. Abactinal aspect of a young specimen: natural size.
 10. Actinal aspect of the same: natural size.
 11. Abactinal aspect of a young specimen: natural size.
 12. Apical disk of the same specimen: magnified.
 13. Longitudinal outline of the same specimen: natural size.
 14. Actinal aspect of very young specimen: natural size.
 15. Longitudinal aspect of the same.
 16. Abactinal view of the same test: natural size.
 17. Peristome of a specimen one inch in length: magnified.
 18. Apical disk and surrounding structure of the same specimen (Fig. 14): magnified.

4. *Plesiolampas rostrata*, sp. nov. Plate XIII, Figs. 1-3.

The test is moderately depressed, slightly longer than broad, broadly elliptical in marginal outline, broadest close behind the eccentric-in-front apical system, rather narrower in front than posteriorly, and having a slightly rounded-off posterior projection, with a faint depression on either side of it, just posterior to the postero-lateral ambulacra. The highest point of the test is at the apical system; and the surface slopes thence to the margin, which is slightly tumid, and least so where the test is pinched in posteriorly. Actinally the surface of the test is faintly convex; but the peristome is deeply seated. The periproct is long, oval, and inframarginal, and it does not touch the margin. The apical system has a large madreporic body. The ambulacra are long, widely open; and there is only the slightest tendency to a petaloid form in the postero-lateral; the anterior is the shortest, and the postero-lateral are the longest. The interporiferous zones are broad, and the ornamentation is irregular, there being spaces where the granulation predominates over the tubercles and scrobicules.

Height of specimen rather more than $\frac{8}{10}$ inch, length 3 inches, breadth $2\frac{7}{10}$ inches.

Locality. Ranikot series, north by east of Petiáni, west of Kotri. Survey-number G $\frac{280}{185}$.

Illustrations of the Species in Plate XIII.

- Fig. 1. The test, from above.
2. The test, side view.
3. The periproct.

5. *Plesiolampas polygonalis*, sp. nov. Plate XIII, Figs. 10, 11.

The test is polygonal in outline, moderately tumid at the ambitus, tumid abactinally, highest behind, very concave actinally. The greatest breadth is at the blunt angular projection over the antero-lateral ambulacra; and the test is narrowed rapidly behind those regions, and less so in front; it is rather truncated behind, and has a wide angle in front. The apical system is slightly eccentric in front, and is over the deeply seated widely transverse peristome. The periproct is inframarginal, elongated longitudinally, and narrow. The ambulacra are narrow, long, open, and very faintly petaloid.

Length $1\frac{7}{10}$ inch, breadth $1\frac{5}{10}$ inch, height $\frac{6}{10}$ inch.

Locality. North-east of Petiáni, west of Kotri, Ranikot series. Survey-number G $\frac{280}{185}$.

Illustrations of the Species in Plate XIII.

- Fig. 10. The test, from above.
11. The test, longitudinal outline.

Genus EOLAMPAS, gen. nov.

Test small, tumid, ovoid, subdepressed; the greatest height corresponding with the apical disk, and very eccentric in front; the anterior slope rapid and precipitous, the posterior subrostrate towards the extremity.

Ambulacra small, short, petaloid, subequal; the odd anterior ambulacrum aborted. Poriferous zones subequal, pores conjugate.

Apical disk eccentric in front, small; generative pores four, and madreporiform body central.

Peristome transversely oval, subcentral or very slightly eccentric in front, with perpendicular wall reaching upward into the body-cavity. No bourrelets. Phyllodes very faintly developed. Buccal pores opening into the peristomial margin, with a small granule-like prominence over each standing at the extreme edge of the peristomial ring.

Periproct marginal, transverse(?).

Tuberculation small, homogeneous, in sunken scrobicules; intermediate space subgranular and confluent.

This genus is closely related to *Echinolampas*; indeed the test might at first sight be regarded as that of a young or abnormal form; but the small and subequal ambulacral petals, the aborted odd ambulacrum, the very anterior apical disk, together with the form of the test and the character of the peristome appear to demand a generic separation. Furthermore, no true *Echinolampas* has hitherto been found in the Ranikot series, whilst the form under notice is recorded from three localities.

Eolampas also occurs in the Khirthar series; and although these beds are very rich in *Echinolampas*, we are unable to refer the form (apart from its special characteristics) to the young of any species there present.

1. EOLAMPAS ANTECURSOR, sp. nov. Plate XVII, Figs. 11-15.

The test is tumid, highest in front, with a precipitous anterior portion and a more gradually sloping and curved posterior part, the top of the test being on a very gradual backward slope. It is longer than it is broad, and broader than high. The transverse outline is nearly hemispherical; and the marginal outline is oval or elliptical, the greatest breadth being about central. The margins are tumid, the actinal surface is slightly hollowed out or concave, there is barely a keel posteriorly, and the anterior and lateral parts of the test overhang the base. The apical system is very eccentric in front, and the peristome is subcentral; the periproct is just above the margin and is small. The apical system is small; there are four small generative plates and pores; and the madreporic body is small and central. The ambulacral rosette is small in relation to the size of the test; and the ambulacral petals end remotely from the margin, and the posterior pair more than their own length from the posterior end of the test.

The anterior ambulacrum has no double pores, but there is a series of broad grooves amongst the ornamentation of the test in their position; the grooves are more numerous than the pairs of pores of the other ambulacra, and no trace of a pore is to be seen in them. A worn test shows neither grooves nor pores in the region of the odd ambulacrum.

The antero-lateral ambulacra form a widely open angle, being nearly transverse in their position; they are petaloid, not closed, and they are slightly broader than the others. The anterior poriferous zone is straighter than the posterior; and the pairs are

not very numerous, are oblique, conjugate, with well-marked intermediate ridges; and their pores are large, circular or slightly elongate in outline, and subequal in the pairs. The interporiferous zone is widest towards the half-distance from the apex. The postero-lateral ambulacra are narrower than those just described, and either slightly longer than or equal to them; and the width of the poriferous zones is less. They form an acute angle at the apex, and are nearly closed distally. The pores are oblique. A single row of wide-apart pores passes over the margins from each poriferous zone; and at the peristome the rows approach to form a rudimentary phyllode whose pores are at the sutures of the plates; and there is no doubling of them. The ornamentation of the petaloid areas is the same as that of the surrounding test, and consists of numerous small sunken scrobicules, with short and broad tubercles in them.

The interradiar areas are largely developed abactinally. The anterior are marked by a larger ornamentation than elsewhere; and the posterior is rounded between the ambulacra and narrow, but it does not form a decided keel; it is slightly pinched in near the margin, on either side of the line leading down to the periproct.

The peristome is at the deepest point of the actinal concavity, large, widely open, deep, transverse, and elliptical in outline, the smallest angles being at the sides. A process composed of the inner parts of the plates around the peristome passes upwards like a short canal; and its surface is minutely granular. The ambulacra of the peristome are narrow; and the first two plates have each a pore on them, which penetrates the plate and looks into the canal just mentioned. The other plates are narrow, and gradually become broader towards the margin.

The edge of the peristome between the phyllodes is slightly raised, and in the natural position projects slightly downwards. The ornamentation of the actinal surface of the test is slightly larger than that of the upper part; and there is a small knob close to the peristome on either side of the ambulacra.

There is a faint groove in front of the peristome; and the anterior margin is slightly incised by it in young specimens. The periproct is supramarginal or marginal, small, and is slightly overhung by the faint keel.

Length of specimen (Figures 11 & 12) $\frac{8}{10}$ inch, breadth $\frac{7}{10}$ inch, height $\frac{5}{10}$; length of a second specimen $\frac{6}{10}$ inch, breadth $\frac{5}{10}$ inch, height $\frac{4}{10}$ inch; length of a third specimen $\frac{5}{10}$ inch, breadth $\frac{3}{10}$ inch, height $\frac{1}{10}$ inch.

Localities. 1. From hills east of Lynyan in gypsaceous shales, high horizon. Survey-number G $\frac{280}{136}$.—2. North-east of Band Vero, from the *Operculina* beds. Survey-number G $\frac{280}{130}$.—3. The same as No. 1. Survey-number G $\frac{280}{127}$. All are from the Ranikot series of strata.

Illustrations of the Species in Plate XVII.

Fig. 11. The side view: natural size.

12. From behind: natural size.

13. Outline of actinal surface: natural size.

14. The apical system and petals: magnified.

15. The peristome: magnified.

*Subfamily ECHINANTHINÆ.**Genus ECHINANTHUS, Breynius.*1. *ECHINANTHUS ENORMIS*, sp. nov. Plate XVII, Figs. 5-10.

The test is tumid, irregularly hemispherical, higher in front than behind, longer than broad, and stands on a small base, which is overhung by the swollen margins. The marginal outline is elliptical and broadest centrally, rounded in front, and very faintly marked by a groove posteriorly in the median line. The test is faintly swollen and convex actinally. The highest point of the test is eccentric in front; thence it slopes rapidly, the anterior longitudinal section being nearly semicircular; behind the slope is gradual and longer to the slightly projecting edge above the periproct. From the periproct, which is rather high up, there is an oblique truncation, so that the test passes from the posterior margin upwards and backwards. On either side of the apex the slope is less convex, so that a conical appearance is given in section.

The apical system is very eccentric in front; and the disk corresponds with the highest point of the test; there are four generative pores; and the madreporic body is small and central.

The anterior odd ambulacrum is dwarfed and very short, it is open and narrow; the poriferous zones are short; and in different specimens there are from 8 to 15 pairs of pores in each zone, which are conjugate. It reaches but a short distance down the rapid anterior slope; and then the inner row of each poriferous zone is continued in single series, which gradually widen apart to the margin, over which they pass to the peristome.

The antero-lateral ambulacra are well developed, form a large angle, are petaloid, moderately open, and have broad interporiferous zones. The poriferous zones are rather narrow; and the subcircular large pores are conjugate, with well-marked ridges between the pairs.

The postero-lateral ambulacra are the longest, form an acute angle, and reach to within their own length of the posterior truncation. Narrower than the antero-lateral pair, more lanceolate, and more open, they are broadest near their inner third.

The interambulacra are largely developed on account of the smallness of the abactinal rosette, and the posterior one is marked by a very faint rounded keel leading to the periproct. The ornamentation is of small tubercles in shallow sunken scrobicules, and it is rather close.

Actinally the test is slightly convex; and the peristome is small, excentric in front, pentagonal, longest transversely (in some specimens the longitudinal axis of the peristome is not quite in the median line). The floscelle is moderately developed; the bourrelets are slightly tumid and project downwards; and the phyllodes are open distally, are short, and have a few double pores.

The ornamentation of the actinal surface resembles that of the abactinal; and here and there minute granules encircle the scrobicules, and others are on the intermediate parts of the test.

The periproct is high up, oval in the longitudinal direction, and has a faint groove below it on the sloping truncation.

The length of the test of one specimen is $\frac{8}{10}$ inch, breadth $\frac{5}{10}$ inch, and height $\frac{5}{10}$ inch. A larger specimen is in length $\frac{7}{10}$ inch, breadth $\frac{6}{10}$ inch, and height $\frac{5}{10}$ inch.

Localities. From hills east of Lynyan, Ranikot series (Survey-number G $\frac{289}{128}$); and north-east of Band Vero in the same group (Survey-number G $\frac{289}{128}$).

Illustrations of the Species in Plate XVII.

Fig. 5. A large specimen, side view : natural size.

6. A smaller specimen (the type), side view : natural size.

7. The same, from behind : natural size.

8. The apical region : magnified.

9. The peristome : magnified.

10. Ornamentation : magnified.

Remarks. Although the shape of the test of this species is very abnormal for *Echinanthus*, we consider that the essential characters of its structure are naturally referable to that genus, of which, however, it will stand as a very extreme form. It is readily distinguishable from any of the species hitherto described.

Genus CASSIDULUS, Lamarck, 1801.

Test of small or moderate size, oblong, convex above, flat beneath, or slightly depressed along the median longitudinal line.

Apical system slightly eccentric in front.

Ambulacra short and very petaloid. Pores conjugate, the external series more elongate than the internal.

Peristome subpentagonal, more or less eccentric in front, surrounded with a well-developed floscelle.

Periproct oval, longitudinal, supero-marginal, placed at the commencement of a short groove which does not indent the margin.

Tubercles small and uniform on the abactinal surface, but much larger on the actinal surface, excepting along a median longitudinal band.

1. *CASSIDULUS ELLIPTICUS*, sp. nov. Plate XV, Figs. 7-10.

The test is long, depressed, elliptical in marginal outline, longer than broad, nearly twice as broad as high, slightly broadest behind the peristome, flat below, with a very slight downward projection of the posterior end, which is truncated for a short distance in the median line. The margin is rounded and tumid in front, and less so and more sharp at the sides and posteriorly. Above, the test is very regularly convex in transverse outline. The longitudinal outline is rather flat behind the slightly eccentric-in-front apical system; there is a faint keel, and then a sudden fall and a sharp slope to the margin. In front the slope is more gradual and faintly curved to the more

rounded anterior margin. The posterior part of the test above, is flatter than the anterior.

The peristome is under the apical system, and is slightly in front of the centre. The periproct is supramarginal, in a deep groove, which slightly flattens out posteriorly, where it terminates at the truncated end of the test. It is narrow and longitudinal, nearly vertical, and under the overhanging test; and its position is considerably behind a line which would unite the extremities of the posterior petals.

The apical system is small; the four generative pores are distinct; and the madreporic body, which does not extend backwards to separate the posterior ocular plates, is well developed and central. The ambulacra are petaloid, and the antero-lateral and posterior are nearly closed; the anterior ambulacrum is the broadest, and the posterior are the largest. The ambulacra are broadest in their apical half, and the zones are well developed; but the posterior poriferous zone of the posterior ambulacra is slightly smaller, especially near the apex, than the anterior zone of the same ambulacrum. Otherwise the poriferous zones are well developed, and one of them is nearly as wide as the interporiferous zone is broad.

The poriferous zones are nearly flush with the test, and the numerous conjugate pores are separated by distinct costal elevations ornamented with a single row of granules. The inner pores are more or less circular in outline, and the outer are smaller and more elongate; and the direction of the conjugate grooves is oblique. The poriferous zones of each ambulacrum are equally bent. The interporiferous zones are very slightly raised, are ornamented with numerous tubercles standing in sunken scrobicules, and which are slightly smaller than those in the interambulacral spaces.

The ambulacra do not reach near the margin; and the end of the posterior is $\frac{5}{10}$ inch from the posterior end of the test, the periproct being $\frac{3}{10}$ inch from the same part. The interambulacra are well rounded off; but there is a faint keel between the posterior lateral, which reaches backwards to the periproct. The ornamentation of the interradians is small on the apical surface of the test, and gradually increases in size at the margin; it consists of small tubercles in sunken scrobicules, with the intermediate area or ridge covered with minute granules.

The peristome is slightly longest longitudinally, is large, pentagonal, and the floscelle is highly developed. The bourrelets are granular and swollen, with tubercles on the lowest projecting point; and the buccal pores are in nearly closed phyllodes, which are petaloid and broad. The reduplicate pores are numerous; and there are two sets of depressions for sphæridia along the interporiferous line.

The ornamentation of the actinal is much larger than that of the abactinal surface, and the tubercles are often placed on one side of their scrobicule and close to the intervening ridges. The large tubercles are seen along the lines of the ambulacra beyond the phyllode; and close to the edge of the test all the ornamentation becomes suddenly small. A cancellated and worm-eaten tract extends in the median line from the mouth to close to the truncated margin, and it is also seen in front of the peristome. It appears to be produced by confluence of granules.

The shallow groove of the periproct has a very small ornamentation, which merges into that of the sharp truncation.

Length of specimens $1\frac{5}{10}$ and $1\frac{3}{10}$ inch, breadth $1\frac{1}{10}$ and $\frac{9}{10}$ inch, height $\frac{5}{10}$ and $\frac{4}{10}$ inch.

Locality. In the Ranikot series, north by east of Petiáni, west of Kotri. Survey-numbers G $\frac{280}{135}$ and G $\frac{280}{135}$.

Illustrations of the Species in Plate XV.

Fig. 7. A specimen of the test, from above.

8. The transverse section.

9. The floscelle and ornamentation: magnified.

10. The ornamentation of part of an ambulacrum.

Genus RHYNCHOPYGUS, *D'Orbigny*, 1855.

Test of small or moderate size, depressed, elongate, convex above, concave beneath. Apical system subcentral or eccentric in front.

Ambulacra subpetaloid, almost straight.

Periproct supramarginal, transverse, surmounted by a more or less developed, subrostrate roof. Peristome pentagonal, subcentral, or only slightly excentric, with well-developed floscelle, the bourrelets being large and the phyllodes highly developed and ornamented. Tubercles much larger on the actinal surface than on the abactinal.

There is much to be said in favour of the classification of Alexander Agassiz, which places this group as a subgenus of the genus *Cassidulus*. We retain it as a genus provisionally; for our ideas of classification develop themselves as this great series of Echinoderms is gradually examined and described.

1. RHYNCHOPYGUS CALDERI, *d'Archiac & Haime*, sp. Plate XV, Figs. 1-4.

Eurhodia Calderi, *d'Archiac & Haime*, *Descrip. Anim. foss. du groupe Numm. de l'Inde*, p. 352, pl. xxx. fig. 19.

A single example of a Cassidulid, which we refer to d'Archiac and Haime's species, is included in the collection of the Echinoidea of the Ranikot series. The specimen is large but badly preserved, and, from not being found in place, doubt exists as to the correctness of its being included in this series. It may have come in from a higher horizon—probably the Khirthar. We have compared this fossil with a series from that group, and find that the accordance both of the form of the test and also of the matrix is exact. Still, as the doubt exists, we mention the species here, and give a description of the imperfect specimen by which it is represented. A more complete detail of structure will be given when we treat of the fossils of the Khirthar group, which is probably the true horizon of the form.

The test is elongate, ovoid in marginal outline, moderately high, and roof-shaped above, rather sharply rounded in front, broader and rounded behind, except on either

side of the median line, where it is truncated and slightly reenteringly curved. Actinally the test is slightly concave. The margin is tumid, but less so posteriorly; and there are projections on it—one at the posterior third, and another close to the truncation. The anterior part of the test of the ambitus is on a slightly higher level than the sides; and there is a corresponding upward slope, posteriorly, starting from the first projection on the margin. The apical part of the test is rather roof-shaped; and there is a rounded eminence passing from the interporiferous zone of the anterior ambulacrum, over the top of the test, backwards to the transverse slit-like process covering the periproct. The test slopes from this long keel, is flatter midway between it and the margin than at the ambitus, and slopes more gently anteriorly than towards the overhanging periproct-ridge.

The apical system is slightly in front of the centre of the upper part of the test; and the anterior odd ambulacrum is large, broad, very open anteriorly, and has broad poriferous zones. The line of the inner pores of the poriferous zones is nearly straight, and that of the outer pores a curve; the interporiferous zone is well developed and broader than one of the poriferous zones. The antero-lateral ambulacra are destroyed, except close to the outer end of one, which is not closed; but the poriferous zones are closer together than in the anterior odd ambulacrum. The posterior ambulacra do not reach to the line of the periproct-ridge; but they are too badly preserved to be described.

The periproct is transverse, is overhung by a projection of the keel, and it is in a broad groove very visible from above, which is slightly hollowed out, and merges by a convex edge into the truncated but slightly reentering margin. The highest part of the test is in rear of the centre, but the abactinal roof is very level.

On the actinal surface there is a larger ornamentation than on the abactinal, and there are traces of a pitted structure in the median line posteriorly.

Length of the specimen $1\frac{7}{10}$ inch, breadth $1\frac{3}{10}$, height $1\frac{8}{10}$ inch.

Locality. There is some doubt whether this form came from the Ranikot series, and it may belong to the Khirthars above. Survey-number G $\frac{389}{135}$.

The list says north-east of Petiáni, west of Kotri (not found in place, probably Khirthar group).

Illustrations of the Species in Plate XV.

- Fig. 1. The test, side view: natural size.
 3. The test, from behind: natural size.
 2. The odd ambulacrum, slightly pitted: magnified.
 4. The surface of actinal median line: magnified.

2. *RHYNCHORYGUS PYGMÆUS*, sp. nov. Plate XV, Figs. 5, 6.

This species is much smaller than the last, but is of the same general shape except in the absence of the long even abactinal keel; the test is more convex in front from the ambitus to the apex than in the other form. The actinal surface is concave from side to side, and the truncation posteriorly barely exists.

The rosette is moderate in size ; and the anterior, odd ambulacrum is characterized by its open extremity, large interporiferous zone, straight inner line of pores, and the curved outer lines. The antero-lateral ambulacra are smaller than the others, and do not reach halfway to the margin. The posterior ambulacra are longer than these last, have a narrow interporiferous zone, have the posterior poriferous zone slightly smaller than its fellow, and they terminate more than halfway from the apical disk to the transverse process above the periproct. All the ambulacra are well open at their ends ; and the straightness of the inner lines of pores is very characteristic. There is a rounded keel over and in front of the transverse oval periproct, which is in a broad shelving groove.

The floscelle of the peristome is highly developed ; and the cribriform structure of the median line is evident, being bounded by a larger ornamentation than exists on the abactinal surface. The large ornamentation consists of tubercles in broad scrobicules, separated by ridges ; several of the tubercles are on one side of the scrobicule.

Length of specimen $1\frac{7}{10}$ inch, breadth $\frac{1}{2}\frac{1}{10}$ inch, height not quite $\frac{1}{2}$ inch.

Locality. In the Ranikot series, north-east of Petiáni, west of Kotri. Survey-number G $2\frac{8}{15}$.

Illustrations of the Species in Plate XV.

Fig. 5. The test, from above : natural size.

6. Part of the phyllode and pitted structure : magnified.

Genus EURHODIA.

Eurhodia, d'Archiac & Haime, *Animaux fossiles de l'Inde*, p. 214.

The superior petals are small, almost closed, and have unequal poriferous zones ; the buccal petals are closed, subequal, and have their inner pores double. The peristome is surrounded by slight and unequal tuberosities ; and the periproct is supramarginal, and opens into a slight depression ; it is large, ovular, and elongated transversely.

This diagnosis was founded in order to separate *Eurhodia* from some other Cassidulids, and especially those of the genera *Pygorhynchus* and *Hardouinia*. It was the result of the study of specimens which were small and had the peristome incompletely shown or badly preserved. Two species were recorded, one *Eurhodia Morrisii*, which replaced *Pygorhynchus Morrisii*, d'Archiac, and *Eurhodia Calderi*, Haime.

The first of these is carefully described by d'Archiac and Haime in their "Animaux Fossiles," p. 214, but not from one good or a large series of good specimens. Hence the correct shape of the test and many specific points are not recorded, and their specific determination becomes almost generic in its value. Moreover the type of the distinguished authors was not full-grown by one third.

Some thirty-five specimens were collected in the Ranikot series ; and as most of them are in good condition, many points of structural importance can be elucidated, and the specific characters slightly amended. But the generic attributes are not cor-

rectly given by MM. d'Archiac and Haime, and it is found that the diagnosis, although remarkably clear, is hardly positive enough, and yet too comparative, especially as it relates to two other genera from which this is distinguished.

Genus EURHODIA, d'Archiac and Haime (amended).

The test is large and stout; it is elongate, oval, and is truncated posteriorly, broad in front, depressed, rather flat, or slightly rounded above, slightly concave actirally and tumid at the ambitus. Apical system and rosette small, eccentric in front; petals small, unequal, open, especially that of the odd ambulacrum. Poriferous zones unequal in size. Peristome large, eccentric in front, very elongate longitudinally, pentagonal; floscelle highly developed; pitted structure in the median line of the test inferiorly.

Periproct elongate transversely, supramarginal, transverse, in a shallow broad groove, which shelves backwards and is surmounted by a rounded roof.

1. *EURHODIA MORRISII, d'Archiac and Haime. Plate XVIII, Figs. 1-7.*

Pygorhynchus Morrisii, d'Archiac, 1850, Hist. des progrès de la Géol. t. iii. p. 248.

The thick test is long, rather depressed, ovoid at the tumid margin, broad in front, widest in front of the centre, on a line with the peristome, and tapering backwards to a posterior truncated edge. The apical surface is highest behind the centre and between the posterior ambulacra; it slopes slightly on a comparatively plane surface to near the end of the odd ambulacrum, and then merges into the boldly convex anterior portion of the test, which unites with the tumid margin. Behind, the slope is more sudden, and there is a rounded low keel, which reaches backwards along a slope very much less defined than the anterior convexity of the test, and which reaches to the edge over the supramarginal periproct. The keel and the test slope on either side rapidly to the sides of the test, so that this part is less tumid and narrower than the anterior portions. The posterior edge of the test is rounded, but is rather sharp; it is nearly straight transversely, but just a little incurved, and the broad shallow periproct-groove slopes upwards and forwards from it. The actinal surface is nearly flat, but there is a longitudinal and central depression, at the anterior end of which is the peristome; posteriorly the actinal surface is very slightly produced downwards.

The apical system is small and eccentric in front; there are four generative pores, and the madreporic is central; the outer pores are well developed. The anterior odd ambulacrum is straight, open, and the outer series of pores of the poriferous zones curves to the straight inner series. The interporiferous zone is broader than one of the poriferous zones. The pores of this and of the other ambulacra are conjugate, and the outer series are more elongate than the inner, which often are circular in outline; the pores of a pair are more widely spaced in the middle of the poriferous zone than at the extremities; and sometimes the conjugation is difficult to trace in the middle of the zone in some specimens. The pores of all the ambulacra are

numerous, and are crowded near the apex in consequence of the narrowness of the ambulacral plates; and the pairs are separated by costal ridges, distinct in some parts and sparsely and irregularly ornamented with granules (Fig. 6).

The antero-lateral ambulacra are petaliform, slightly open, and are as long as but broader than the anterior odd ambulacrum. The poriferous zones are curved and even slightly sinuous distally, especially the posterior; and the interporiferous zone is broader than that of the other ambulacra. The posterior lateral ambulacra are the longest; they are nearly closed, form an acute angle, and reach back to within one and a half times their length of the periproct. The inner or posterior poriferous zones are narrow and nearly straight; and the outer are much the broadest and curved; the distinction between the two zones is very decided. All the ambulacra are nearly flush with the test, and their interporiferous zones are covered with a small tuberculation resembling that of the interambulacra of the upper part of the test. The tubercles are minute, sunk in a deepish scrobicule, and are rather wide apart. The tubercles are without order, but at the end of the anterior odd ambulacrum they assume a linear convergent arrangement, and form a series of successive vandykes, the angle being outwards and forwards. The ambulacra are continued over the margin, a very small pore being seen here and there.

The ornamentation of the upper part of the test is very equal and small; it becomes crowded at the margins, and at the under surface it gradually increases in the dimensions of the tubercles and scrobicules, until the largest are found close to the peristome. Beneath, the tubercles have a boss and mamelon and are perforate, and are separated by minute granulations.

The peristome is beneath the apical system, is longer than broad, elongate, longitudinally narrow, pentagonal, and narrowest and angular anteriorly. It is deep, and the floscelle is well developed.

These buccal petals are broad, nearly closed, a tubercle often interposing between the poriferous zones at their ends, wide apart; and their poriferous zones are well developed, and marked with grooves and costæ.

The poriferous zones have numerous pores in the outer row, and about half the number in the inner row, connected by grooves which are rather wide apart.

The inner pores are doubled in most instances; and very frequently the innermost series appear to be aborted and blind, possibly modified into sphaeridia-pits. Two pores are within the peristome.

The anterior petal is usually the broadest, and is arched around by a small pitted space whose pits are rather deep and small and irregularly placed. This space is continued forwards, and also extends sometimes on both flanks of the anterior petal. The antero-lateral buccal petals are more pointed than the odd one, and are surrounded by a row of large tubercles.

The postero-lateral ambulacra also have a tubercle at their open distal end, and posteriorly they are bounded by the commencement of the median pitted space, which reaches forwards to the posterior edge of the dense peristomial lip. The buccal petals

are slightly concave at their interporiferous zones; and these portions contract within and slope upwards into the mouth in flat stalk-like processes.

The interambulacra end, actinally, in short, slightly downward-projecting, broad processes or bourrelets, which are covered with an exceedingly delicate granulation. They pass upwards, forming the sides of the peristomial pentagon, and are concave externally between the phyllodes where they are in contact with the pitted spaces or regions of large tuberculation. The posterior pitted space reaches the posterior margin of the test, and diminishes gradually in width.

The periproct is large, transverse; and the broad edge of the slight posterior inter-radial keel overhangs it. The floor of the periproct, slightly concave and broad, merges into the posterior shelving process, which terminates in a rather sharp edge at the posterior truncation of the test.

Length of specimens.	Breadth.	Height.
$2\frac{9}{10}$ inches.	$1\frac{8}{10}$ inch.	1 inch.
$2\frac{2}{10}$ „	$1\frac{5}{10}$ „	not quite 1 „
2 „	$1\frac{4}{10}$ „	$\frac{11}{12}$ „
$1\frac{6}{10}$ „	$1\frac{1}{10}$ „	$\frac{7}{10}$ „

Locality. North-east of Petiáni, west of Kotri, Ranikot series (Survey-number G $\frac{280}{35}$); also at Jhirak, Ranikot series (Survey-number G $\frac{280}{246}$).

Variety. With a narrow interporiferous zone to the odd ambulacrum; the test more elliptical and larger behind than the type; other structures the same.

Several specimens of this variety occur; and there is some variation in regard to their height and breadth; they are mostly smaller forms, but most are more than 1 inch in length.

Localities. South-west of Jhirak; hills east of Lynyan; from gypseous shales, Jhirak. Survey-numbers G $\frac{280}{165}$, G $\frac{280}{1205}$, G $\frac{280}{1245}$.

These are all from the Ranikot group.

Illustrations of the Species in Plate XVIII.

Fig. 1. The test, from above: natural size.

2. Side view: natural size.

3. Transverse outline.

4. Actinal surface: natural size.

5. Apical system: magnified.

6. Part of an ambulacrum: magnified.

7. The floscelle: magnified.

Genus PARALAMPAS, gen. nov.

Test of small size, suboval, high, and convexly inflated above, greatest elevation posteriorly eccentric; slightly concave beneath, margins very tumid.

Ambulacra petaloid, short, subequal, closely approximating at the extremities distally; poriferous zones equal; pores equal, round and conjugate.

Apical disk compact, slightly eccentric in front.

Peristome pentagonal, more or less eccentric in front, slightly widest laterally; floscelle well developed, with wall-like bourrelets.

Periproct suboval, supramarginal, high, overhung by a well-developed supra-anal rostration, with a more or less defined groove beneath.

Tubercles small, uniform, crowded, equidistantly placed, sunken in deep scrobicules; slightly larger and more widely spaced on the actinal surface.

This genus resembles *Rhynchopygus* to a certain extent in consequence of the overhanging character of the supra-anal portion of the odd interambulacrum, but differs widely in the great height and posterior eccentricity of the elevation of the test, and is further distinguished by the small and petaloid ambulacral rosette, the equal pores, the comparative simplicity of the floscelle, the absence of a median, pitted, actinal band, and the small and homogeneous character of the actinal tuberculation, which is very slightly larger than that above the ambitus. It differs from *Pygorhynchus* in the form of the test, the character of the ambulacra, the structure of the floscelle, and the absence of the median band. It is distinguished from *Echinanthus* by the form of the test, the supra-anal rostration, and the proportions and character of the petals and pores. From *Catopygus*, to which the form of the test presents a somewhat exaggerated resemblance, it is well defined by the character of the ambulacra, the concave actinal surface, and the structure of the floscelle.

1. PARALAMPAS PILEUS, sp. nov. Plate XV, Figs. 11-14.

The test is high, longer than broad, broadest posteriorly, very convex above, and rather concave below, except at the tumid margins. The sides of the test are swollen and project outwards more than the margins, and slope up roundly to the top. The greatest height is between the distal ends of the posterior ambulacra; and thence the test slopes forwards, slightly, to the apical system, which is eccentric and in front, and roundly and sharply backwards to the ridge over the narrow periproct, which is about two thirds of the distance from the margin. The transverse outline of the test above the ambitus is nearly semicircular, but there is a slightly angular summit. At the margin the test is rounded and narrow in front and broadly rounded behind; and there is a concave surface along the actinal median line.

The peristome is small, eccentric in front, transverse and pentagonal. There is a projecting ridge or lip from each interambulacral space or bourrelet; and traces of double pores are seen in one part of this badly preserved portion of the test.

The apical system is eccentric and slightly in front, and is moderate in size; the madreporiform body is central; and there are four generative pores. Near it, the interambulacral spaces are excessively narrow, in consequence of the rather abruptly broad petals of the trivium. The anterior odd ambulacum, the longest, is petaliform, passes along the anterior declivity of the test, does not reach the margin by a distance nearly

equal to its length, is open distally, and has a very broad interporiferous zone. The poriferous zones are equal, rather narrow, and the pores are circular in outline or slightly elliptical. The pairs of pores are rather oblique, are crowded near the apex, and much wider apart distally; and the pores are conjugate. The ambulacrum is broadest midway, and is flush with the test. The antero-lateral ambulacra are shorter than the others, have a tendency to close, are petaloid and broad in the interporiferous zone. They diverge greatly, but are not transverse, and they do not reach to the most swollen part of the side of the test. The posterior ambulacra are rather close, and are narrower than the antero-laterals; they end very far from the periproct-groove, and more than their own length. The poriferous zones of the ambulacra have a close resemblance. There are 27 pairs of pores in the odd ambulacrum, and 25 in the others. The large interporiferous zones are very characteristic.

The peristome is beneath the apical disk.

The periproct is in a decided groove, with a shelving process, which reaches the tumid margin, and is covered at about halfway up the posterior part of the test by a roof-like ridge. The periproct is longitudinal rather than transverse.

The ornamentation of the test is that of very small tubercles or sunken areolæ; and there is a fair amount of intermediate raised reticulation.

Length $\frac{3}{4}$ inch, breadth $\frac{9}{10}$ inch, height $\frac{5}{10}$ inch.

Locality. Hills east of Lynyan, from gypsaceous shales, Ranikot series. Survey-number G $\frac{280}{126}$.

Illustrations of the Species in Plate XV.

Fig. 11. The test, side view: natural size.

12. View from behind: natural size.

13. Marginal outline, from below.

14. The apical system: magnified.

2. PARALAMPAS MINOR, sp. nov. Plate XVII, Figs. 1-4.

The test is small, almost hemispherical, stands on a small base beneath the overhanging tumid margins; it is as long as broad, and slightly longer than high, broadest midway between the peristome and the posterior margin, slightly truncated posteriorly, and decidedly concave actually around the peristome. The marginal outline is elliptical, and broadest behind. The highest point superiorly is central, and is situated between the posterior ambulacra. The apical system is eccentric in front and on the rounded anterior slope. The peristome is more central than the apical system, and the periproct is high up, circular in outline, and at the top of the posterior truncation, which has a faint groove.

The apical system and subequal petaloid ambulacra are small; there are four generative pores, and a small central madreporic body. The anterior odd ambulacrum, well developed, is nearly closed; the pores, large and circular in outline, are conjugate; and the grooves are oblique; and the interporiferous zone is fairly developed. The

antero-lateral ambulacra form a very open angle, are nearly closed; the conjugate grooves are oblique, and the posterior poriferous zone is more curved than the anterior. The postero-lateral ambulacra are nearly closed, are rather close together; and the conjugate grooves are oblique. The extremities of these ambulacra are about $1\frac{1}{2}$ times the length of the petals from the periproct. The interporiferous zones of the lateral ambulacra are narrow distally, and in all cases are sparsely ornamented like the surrounding interradial area.

The interradial areas are large, and are separated by the long continuations of the ambulacra beyond the petaloid portions. These continuations are broader than the ambulacra as they reach the margin, although narrow at the end of the petals; they are marked by a series of solitary pores on either side. The posterior interambulacrum is rounded between the ambulacra, and then slopes with a very equal convexity backwards and downwards, forming hardly a trace of keel, and reaches the periproct. The ornamentation of all the interradials is small, close, equal, and consists of small tubercles in sunken scrobicules, the intermediate raised portion of the test being scanty.

The peristome is sunken, subcentral, pentagonal, largest transversely, and deep. The floscelle is moderately well developed. The bourrelets are narrow and project downwards, with rounded edges; and the phyllodes are not petaloid, but are open externally and small peristomially. There is a slight reduplication of pores, and the first pair are very visible at the peristomial edge.

The actinal ornamentation is of the same character as the abactinal, but slightly larger.

Just above the rounded-off posterior margin the test is very slightly truncated; and there is a shallow median groove with a faint ridge on either side leading up to the periproct.

The length of the type is $\frac{5}{10}$ inch, and the extreme breadth is the same; the height is $\frac{4}{10}$ inch.

Locality. Hills east of Lynyan, gypsaceous shales in the Ranikot series. Survey-number G $\frac{280}{126}$.

Illustrations of the Species in Plate XVII.

- Fig. 1. View from the side: natural size.
 2. From behind: natural size.
 3. The apical system and petals: magnified.
 4. The peristome: magnified.

Remarks. This species is very nearly allied to *P. pileus*, but differs in the more conoidal and more tumid form of the test. The periproct is higher up, the median keel and the overhanging supra-anal ridge are much less developed, and the infra-anal groove is narrower and more clearly defined. The ambulacral petals are comparatively smaller, and the interporiferous areas narrower, than in the preceding species. These differences appear sufficient to warrant the recognition of the independence of this form,

although it is quite possible that it may be the young stage of a well-defined variety of *P. pileus*.

Genus NEOCATOPYGUS, gen. nov.

Test of moderate size, tumid and high, subrotund marginally, greatest height posteriorly eccentric. Abactinal area convex, sides tumid and high; actinal surface convex. Posterior extremity subrostrate and prominent, tumid actinally.

Ambulacra petaloid, petals short and subequal, open at the extremity; poriferous zones subequal, pores unequal and conjugate. Extrapetalous pores single.

Peristome small and pentagonal, eccentric in front. Floscelle well developed; bourrelets forming an ornamented wall-like rim; phyllodes with an inner series of supplemental pores.

Apical disk small and compact, slightly eccentric in front; four generative pores; madreporiform body placed centrally.

Periproct small, subcircular or oval, supramarginal, placed at the extremity of the posterior rostration, by which the aperture is slightly overhung. The subanal area, which is tumid and rostrate, is faintly grooved.

Tubercles small, perforate and crenulate, sunken in deep scrobicules, intermediate space granular, the encircling ring of the scrobicule often well defined. Actinal ornamentation coarser than above the ambitus.

This genus recalls *Catopygus* to a certain extent, but is readily distinguished by the form of the test, the small ambulacral rosette, the single series of extrapetalous pores, the character of the floscelle, the position of the periproct, and the character of the posterior rostration.

The form is well defined, and further comparison with other genera of Echinolampinae seems superfluous.

The forms included in this genus differ much from the modern *Catopygi*, and are as remote from them as from the Cretaceous forms.

1. NEOCATOPYGUS ROTUNDUS, sp. nov. Plate XVI, Figs. 1-10.

The test is very tumid, broadly oval or cordiform in marginal outline, rounded in front, rather pointed behind, broadest at a lateral projection, which is anterior to a narrowing immediately anterior to the faint subanal rostrum. The test is highest posteriorly midway between the distal ends of the posterior lateral ambulacra, and it slopes gradually in front to the very tumid ambitus, and more suddenly posteriorly to the periproct, which is three quarters of the distance from the upper part of the test to the lower; thence the outline of the test passes obliquely downwards and forwards. The sides of the test are tumid, and slope up gradually to the apex, and more suddenly to the slightly convex actinal surface. The apical surface is convex; and the convexity of the posterior interambulacral area is interfered with, along the median line behind the point of greatest height, by a shallow groove with faintly raised edges. This groove, with its edges, becomes slightly raised near the periproct; and the structure is continued

inferiorly down to the rounded-off and slightly projecting posterior rostral process. The test is slightly longer than broad, and broader than high.

The apical system is small and rather eccentric in front; there are four generative pores; and the madreporic body is placed centrally and is slightly prominent. The ambulacra are small in relation to the surface of the test, do not extend beyond the moderately convex upper surface onto the tumid sides, and are subequal, petaloid, and do not close. They are nearly flush with the test. The interporiferous zones, slightly above the level of the test, are broadest at the commencement of the distal third, and are about double the width of a poriferous zone; and their ornamentation is of a few small tubercles in sunken scrobicules. The poriferous zones have the pores placed rather obliquely, and the outer set are larger and more oval than the rounder inner series. They are conjugate, and the costal ridges are granular. The pairs of pores are close, and the plates of the ambulacra are numerous. The posterior lateral petals are slightly the longest and contain the most pores; and the antero-lateral petals diverge greatly, forming an angle of about 60° – 66° . A row of numerous single pores passes from each poriferous zone over the ambitus; and the two rows forming the extrapetaloid ambulacrum diverge on leaving the ends of the petals.

The interambulacra are wide and conform to the slight convexity of the test; their ornamentation is of sparsely distributed tubercles in sunken scrobicules, the intermediate surface being ornamented with granules which are often arranged in circles around the scrobicules, or the spaces may be minutely punctated.

There is a certain gibbosity placed longitudinally along, or rather posterior to, the median suture of the interradian area between the antero-lateral and postero-lateral ambulacra.

The peristome is very small; it is more eccentric in front than the apical system, is pentagonal, with slightly re-enteringly curved bourrelets, and it is slightly longer transversely than longitudinally; and the floscelle is well developed. A wavy ornamented rim projects downwards from the bourrelets and from the sides of the proximal part of the phyllodes. The buccal ambulacra or phyllodes have open ends, which expand into the long line of single pores, and they have supplementary pores and also central pits. The ornamentation of the test is coarser actinally, and some of it is within the poriferous zones of the phyllodes.

The periproct is small, supramarginal, low down; it is almost circular, or surmounted by a slightly projecting ledge of the flat grooved keel; and there is a faint groove leading from it downwards and forwards to be lost on the tumid posterior rostrum.

Length of the test $1\frac{4}{10}$ inch, breadth $1\frac{3}{10}$ inch, height 1 inch.

Locality. Hills east of Lynyan, from the gypseous shales in the Ranikot series. Survey-number G $\frac{280}{126}$.

There are many specimens of different sizes of this species in the collection.

Some of these are from an uncertain locality, and are numbered G $\frac{280}{128}$, but they evidently belong to the same species and can hardly be called varieties.

In all the tumid test, the slightly eccentric-in-front and small apical rosette, the more eccentric-in-front and small and transverse peristome, with a well-developed floscelle, the faint keel, and the projecting but low-down periproct and the extra-petalous row of solitary pores are very distinct and characteristic.

Illustrations of the Species in Plate XVI.

- Fig. 1. The test, from above : natural size.
 2. The test, from below : natural size.
 3. The floscelle and peristome : magnified.
 4. The test, side view : natural size.
 5. The posterior end : magnified.
 6. The transverse outline.
 7. The apical system : magnified.
 8. A small specimen, from above.
 9. The ornamentation : magnified.
 10. Part of an ambulacrum : magnified.

Family SPATANGIDÆ.

Genus HEMIASTER, Desor, 1847.

The test may be short and inflated, or dilate and cordiform.

Apical system subcentral, or more frequently eccentric posteriorly.

The paired ambulacra are petaloid, more or less unequal, placed in furrows; their poriferous zones are broad and equal, pores elongate. The odd ambulacrum often narrower than the rest, and placed in a less defined groove; its poriferous zones are very narrow, and composed of very small round pores forming a simple series of widely spaced obliquely placed pairs.

Peristome bilabiate, very eccentric in front.

Periproct on the posterior extremity.

A single fasciole, peripetalous, more or less angular, surrounding the ambulacral petals.

Tubercles perforate and crenulate, not sunken in scrobicules; small, uniform, and crowded on the abactinal surface, rather longer on the actinal surface.

1. *HEMIASTER ELONGATUS*, sp. nov. Plate XIX, Figs. 7-15.

The test is long, depressed, tumid at the ambitus, slightly convex actinally, rather rounded apically, highest posteriorly, posterior margin slightly truncated above a sharp plastron-point and below the elliptical transversely placed periproct. It is longer than broad, and broader than high.

The marginal outline is ovoid, broadest centrally, broader in front than behind, where the test diminishes in breadth rapidly. The anterior margin is well rounded, the groove not reaching to the ambitus; and on a line with the antero-lateral ambulacra there is some marginal flattening. A side view of the test shows the tumid margin sloping backwards more rapidly than forwards; the highest point is far back; thence the test slopes backwards rapidly over a very flat broad keel to overhang the periproct, and forwards more gradually but decidedly to the low tumid anterior margin. The test stands on a smaller base than the margin; and the height of the test diminishes rapidly in front of the very eccentric-in-front peristome. Posteriorly and below is the pointed plastron-end, and the test slopes rapidly upwards and backwards, and then nearly upwards to the periproct. The outline of the test seen from behind is depressed at the sides, pointed below, faintly rounded and keeled above. Anteriorly, the outline indicates a rounded actinal surface, showing the opening of the peristome, a low tumid margin, and a broad low ambulacral groove with a low keel on either side of it.

The apical system is slightly behind the centre of the test, is small, and is situated on a narrow transverse keel of the lateral interradia. The peristome is very eccentric in front. The periproct is situated about three fourths of the distance from the pointed end of the plastron to the summit of the test.

The apical system is compact and small; the madreporic body is small, and separates the posterior ocular plates, but does not extend into the posterior interradiar area; there are only two generative pores, and they are situated at the tops of truncated cones separated at their bases by the granular surface of the madreporic. The cones are at the extremities of a narrow transverse ridge. The right and left antero-lateral generative plates are very small, and they are not perforated by pores; and the postero-lateral plates are the largest and are perforated. There is no posterior generative plate. The ocular plates are well developed, and are placed in hollows, and intrude on the generative-plate edges.

The odd anterior ambulacrum is in a shallow groove, which widens and shallows anteriorly until it is just lost at the ambitus; there is a keel on either side, which diverges from its fellow, and which, well developed near the apical system, gradually broadens and becomes lower anteriorly. The keels slope rather rapidly towards the base of the groove; and the ambulacral pairs of pores are situated partly on the base and partly on the slope. They are few in number, are oblique, and the pores of each pair are separated by a small tubercle. Beyond the fasciole the pairs become very rare.

The antero-lateral ambulacra, in shallow grooves, are small, form an angle of about 90°, are petaloid, very nearly closed, slightly sinuous, broadest in the outer half, and fairly rounded close to the fasciole which closes them. The poriferous zones are large and on different levels, the anterior being on the slope of the test, caused by the keel of the anterior odd ambulacrum, and the posterior nearly flat. The pores are conjugate, rather wide apart, elongate, and the inner are the smallest; near the ocular end the pores of the anterior poriferous zone are smaller than those of the posterior,

and as a whole the anterior series are more bent than the posterior. The interporiferous zone is shallow, and not as broad as one of the poriferous zones. The postero-lateral ambulacra diverge nearly as much as the antero-lateral, are much smaller than the others, are slightly longer than broad, rounded, and nearly closed close to the fasciole, are in shallow grooves; and the pairs of pores are few, 8 to 11 in number. There are a few minute granules on the ridges between the pairs of pores, and there is a distinct longitudinal line in the interporiferous zones. Beyond the fasciole the pores of the ambulacra are in single series; and they reach the peristome, where they become more numerous.

The antero-lateral interradia are swollen by the keels of the odd ambulacrum, and become broader anteriorly; they are very narrow near the apex, between the pores of the odd ambulacrum and the anterior poriferous zones of the antero-lateral ambulacra; and this part is keeled. The postero-lateral interradia are also narrow at the apical system, and are formed there into a long but narrow keel; this expands rapidly into the general convexity of the test beyond the limits of the ambulacra. The posterior interradium is very faintly keeled between the ambulacra, and it rises gradually to a point rather posterior to them; it slopes on either side to the line of the continuation of the ambulacra, and posteriorly more sharply, and is rounded off just above the periproct. The plastron is long, narrow, pointed, and lowest posteriorly, is generally convex from side to side, and the lip on the anterior end is slightly prolonged downwards.

The peristome is small, much the longest transversely, has a rim, and is round at the sides. The periproct is elliptical and broader transversely than from above downwards; there is a very faint flattening just below it.

The fasciole is well developed and is peripetalous. It is broad, and marked with many rows of granules at the end of the antero-lateral petals; it passes thence backwards slightly, and then turns towards the apical system, running nearly parallel with the antero-lateral petals for a short space; then it crosses over, not going far into the angle between the petals, narrows considerably, and passes backwards and inwards to reach the distal end of the posterior petals. It enlarges as it bounds their end, and then crosses over the keel, narrowing and having a slight convexity backwards. In front, the fasciole starts from the end of the antero-lateral petals, narrows and mounts the keel on the outside of the odd ambulacrum, taking a direction forwards and inwards; still narrowing, it passes forwards, but with a less inward course, and crosses the median line with a sharp curve, enlarging again there, the convexity being forwards; this part of the fasciole is slender, and is much nearer the ambitus than the apical system.

The ornamentation is remarkable for its variation in size and detail. Posteriorly the ornamentation is small, and consists of very small tubercles with still smaller ones between them; they are crowded, and give a granulated appearance. This ornamentation increases in size and definition on the sides towards the fore part of the postero-lateral interradia; and the tubercles are seen to be surrounded by a row of

smaller ones, or they merge into a raised rim around. • In the antero-lateral region this ornamentation is still larger and more pronounced; but along the line of the odd ambulacrum, over the ambitus, the tubercles become smaller and rarer, and moniliform circlets of minute tubercles are seen. The tuberculation is large and distinct on the keel between the postero-lateral ambulacra and on the transverse keel beyond the generative pores; it is also large on the inner slope of the keels of the anterior odd ambulacrum, and it is largest and sparest of all below the ambitus in front of and at the sides of the peristome. The posterior ambulacra, actinally, are marked with an ornamentation of long and radiating moniliform lines of granules; and the plastron between them has its ornamentation of rounded tubercles on flat scrobicules, small posteriorly and large in front; and the lines of tubercles seem to radiate from the posterior keel-end.

Height of specimens.	Length.
$\frac{7}{10}$ inch.	$1\frac{1}{10}$ inch.
$\frac{4}{10}$ "	$\frac{7}{10}$ "
$\frac{4}{10}$ "	$\frac{6}{10}$ "
$\frac{3}{10}$ "	$\frac{5}{10}$ "

The largest specimen is $\frac{7}{10}$ inch broad. Some forms are slightly broader in front than others; and rarely there is an impression of the groove at the ambitus in front. The young forms are more globular than the older ones.

Localities. In the Ranikot series, north by east of Petiāni (Survey-number G $\frac{280}{135}$); hills east of Lynyan, from brown limestone (G $\frac{280}{126}$ and G $\frac{280}{127}$); east of Kandaira, in Vero plain (G $\frac{280}{155}$) and Jhirak (Survey-number G $\frac{280}{124b}$).

Remarks. We are unacquainted with any species for which the present form might be mistaken. It is especially distinguished by the elongate test, the egg-shaped and regularly rounded marginal contour, and the characters of the petals and apical disk.

Illustrations of the Species in Plate XIX.

Fig. 7. Upper view: natural size.

8. Actinal surface: natural size.

9. The apical system: magnified.

10. The longitudinal outline: natural size.

11. Ornamentation on the anterior keel: magnified.

12.)
13.) Outlines of young forms: natural size.
14.)

15. Test, from behind: natural size.

2. HEMIASTER, sp.

There is a single small example of what was probably a *Hemiasiter* in the collection; but the test is unfortunately so much crushed, weathered, and badly

preserved as to be perfectly undeterminable. From such characters as can be made out, the form was possibly identical with, or at any rate nearly allied to, *H. digonus*, d'Archiac.

As this form is very abundant in a higher horizon, it is unnecessary to refer to the species at greater length in the present place; and the specimen is so unsatisfactory that we should not have mentioned it, excepting for the interest which attaches to it as a probable record of the presence of that species in the Ranikot series.

Locality. North by east of Petiáni, west of Kotri, Ranikot series. Survey-number G $\frac{280}{135}$.

Genus LINTHIA, Merian, 1853.

(See *antea*, p. 17, part i.)

1. LINTHIA INDICA, sp. nov., and a variety. Plate XX, Figs. 1-8.

The test is broadly oval, depressed, with an angular outline, notched in front, narrowed and truncated behind. It is widest just behind the centre, and the marginal outline is wider and more rounded in front than behind. The apical surface slopes in front from a low, rounded, sharp, narrow keel, which separates the posterior ambulacra and overhangs the periproct, the highest point being behind the posterior ambulacra. The actinal surface is slightly rounded and convex; and there is a downward-projecting posterior point to the plastron. A front view of the test shows the tumid and somewhat nodulose margins or flanks, the anterior groove for the odd ambulacrum keeled on either side near the apical system, and behind it the sharp narrow triangular outline of the keel of the posterior interradium.

The apical system is slightly in front of the centre, is small, and is placed on a depressed area formed by the junction of the raised posterior keel, the narrow keels of the lateral interradial areas, and the keels of the anterior odd ambulacrum.

There are four generative pores, and the anterior and posterior pairs are rather close together; the anterior pair of pores are much closer than the posterior pair, which are wide apart. The right anterior plate is in relation with the madreporic body, which separates the posterior pair of plates widely, and which passes slightly backwards and separates the posterior ocular plates. The anterior generative pores are on a line with the ocular pores of the odd and antero-lateral ambulacra, and the posterior ocular pores are on a line with the anterior and posterior generative pores.

The peristome is rather close to the anterior margin, and the periproct is high up in the posterior truncation.

The groove for the anterior odd ambulacrum is rather deep, and becomes shallower and broader towards the margin, which it notches decidedly; it is continued more or less on to the peristome.

A few sets of pairs of pores are on the flanks of the groove, and the twelfth pair are crossed by the fasciole. Each pair is in a shallow hollow, and the pores are oblique and separated by a granulation.

The antero-lateral ambulacra are long, on rather deep grooves, faintly flexuous, rounded, and nearly closed where the fasciole bounds them, and narrow apically. The anterior poriferous zone is on the flank of the groove, the narrow or interporiferous zone is on the floor, and the posterior poriferous zone on the other flank, and, like its fellow, is steeper near the apical system than in the outer third. The pairs of pores are separated by granular costæ; and there are from 20 to 23 pairs of pores. The angle formed by the diverging ambulacra is about 110° – 115° .

The posterior lateral ambulacra are small, petaloid, close, separated by a narrow keel, rather deep, nearly closed, rounded where in contact with the fasciole, and the outer poriferous series is more curved than the inner. There are from 14 to 16 pairs of pores. Their grooves are comparatively shallow.

The interradiar areas are narrowed at the apex, and form moderately elevated, narrow, rounded keels, ornamented with a few distant tubercles. On the flanks the plates have a slight bulge; and thus a series of longitudinal elevations is formed, rendering the test slightly gibbose.

The ornamentation is largest in the anterior interradium, and especially on the margins, and it becomes larger and sparser near the peristome. It is smaller in the lateral interradia, behind a narrow line of minute granulations resembling a fasciole, which passes along the surface of the extrapetaloid part of the antero-lateral ambulacra. The ornamentation consists of low rounded tubercles or faintly rounded scrobicules. The surface around the peristome is free from ornamentation; and the plastron has a large ornamentation in regular oblique rows, which diminishes towards the posterior point.

The peristome is broader than long, is narrow from behind forwards, rounded at the outer angles, and is on the whole slightly curved and crescentic. The posterior lip is on a lower level than the anterior edge; the whole edge has a rounded-off rim. The ambulacral pores are scanty in number.

The periproct is oval, longitudinal, high up, and is in the posterior truncation, which is slightly hollowed out and bounded by faint ridges which enclose an oval space and pass over the margin to unite at the point of the plastron.

The peripetalous fasciole is in relation with the gibbous swelling of the plates along its course. It is broad at the rounded ends of the antero-lateral petals, and passes forwards and inwards as a narrower band to a gibbosity on the keel of the odd ambulacrum, over which it passes with a bend, the convexity forwards, not far from the margin. Behind, the fasciole passes along the edge of the end of the antero-lateral ambulacra, backwards and inwards to a gibbosity, and then enters the angle, passing close to the commencement of the narrow keel of the lateral interradium. Thence it reaches the anterior edge of the posterior petal, which it bounds; turning round the termination of the petal, it crosses directly over the narrow posterior keel to the other side, and pursues a corresponding course. The fasciole is broadest close to the outer part of the antero-lateral ambulacra, and is narrow elsewhere.

The lateral fasciole is very narrow; it starts from the gibbosity behind the outer

part of the antero-lateral ambulacrum, which is marked with the peripetalous fasciole, and passes backwards and downwards to reach the lower part of the truncation close to the margin of the test, which it crosses with a downward curve.

There are many specimens of this *Linthia* in the collection from the Ranikot series: some have been slightly crushed; others (which are younger) have not. There appear to be two forms—that which has just been described, and a smaller. These last have a more globose and less depressed appearance; but in all the other points they correspond with the first.

Length of the type specimens.	Breadth.	Height.
$\frac{1.8}{2.0}$ inch.	$\frac{1.7}{2.0}$ inch.	$\frac{1.4}{2.0}$ inch.
$\frac{1.9}{2.0}$ "	$\frac{1.9}{2.0}$ "	$\frac{1.3}{2.0}$ "
$\frac{1.8}{2.0}$ "	$\frac{1.7}{2.0}$ "	$\frac{1.2}{2.0}$ "
$1\frac{1}{2.0}$ "	1 "	$\frac{1.2}{2.0}$ "
$\frac{1.4}{2.0}$ "	$\frac{1.4}{2.0}$ "	$\frac{1.2}{2.0}$ "

Length of specimen of variety.	Breadth.	Height.
$\frac{1.8}{2.0}$ inch.	$\frac{1.7}{2.0}$ inch.	$\frac{1.3}{2.0}$ inch.
$\frac{1.4}{2.0}$ " not quite	$\frac{1.4}{2.0}$ "	$\frac{1.2}{2.0}$ "

Locality. North-east of Band Vero, Ranikot series. Survey-number G $\frac{280}{130}$.

Illustrations of the Species in Plate XX.

- Fig. 1. Actinal view.
2. Side view.
3. Apical system: magnified.
4. Side view of variety.
5. Fig. 1 from above.
6. Posterior view.
7. Young form: side view.
8. Posterior view.

Remarks. We were at first disposed to refer this form to the *Linthia Arizensis*, d'Archiac, sp.; but a careful study of the specimens contained in the collection has convinced us that the differences are greater than would justify us in maintaining such a conclusion. The outline of the test is broader, more angular, and with prominent gibbosities; the posterior height is much greater, the anterior slope is more rapid, the posterior sloping truncation is concavely impressed; the ambulacra are in much deeper grooves; the anterior petals are wider and more rounded at their distal extremities, and the posterior pair are directed more backward and consequently at a smaller angle of separation; on the actinal surface the plastron is broad and well tuberculated, and the

bare ambulacral areas are comparatively narrow ; and, finally, the peristome is situated further from the margin.

In the variety (Plate XX, Fig. 4) the resemblance to *L. Arizensis* is still closer, excepting that the height of the test is greater and more tumid, and the actinal surface is also more tumid, the ambulacra are less deeply sunken, and the posterior pair are comparatively a shade longer than in the type. This form is unquestionably the representative of *L. Arizensis* in the Ranikot strata.

This *Linthia* is distinguished from *L. Sindensis*, Duncan and Sladen*, from below the Trap, in the angle made by the antero-lateral ambulacra, the size of the posterior ambulacra, and the position of the peripetalous fasciole. There is also a great distinction in consequence of the difference in the position of the apical system.

The older form has wider-apart antero-lateral ambulacra than the species *Indica*, and it has the apical system well in front of the centre. This is not the case in the Ranikot form, which, in the position of the apical system, resembles somewhat the *Schizasters*.

Linthia Indica is an approach to the genus *Schizaster* ; and had it a more attenuated posterior part, and the antero-lateral ambulacra closer to the anterior, and the pores crowded in the odd ambulacrum, it would be a *Schizaster*.

2. LINTHIA, sp. Plate XX, Fig. 9.

A specimen much worn on the upper surface, and nearly entirely destroyed actinally, is in the collection from the Ranikot series. There are some points about the form which ally it with some of the large Nummulitic *Linthias* ; but until better specimens are obtained it is not necessary or advisable to give it a specific name, especially as it has considerable affinities in some points with *Linthia Delanouei*, of De Lorient, from the Nummulitic of Egypt.

The shape of the outline of the test is cordiform, about as long as broad, slightly broadest in front, with a slanting rostrum posteriorly. The apical system is nearly central from the periproct to the slight anterior notch, but eccentric in front from the lower end of the rostrum to the same position in front.

The anterior groove is moderately deep near the apical system, and broader and shallower towards the front, where it faintly notches the ambitus. The pores in it are small, separate in pairs, with a rounded costal elevation between each pair on the slope of the side of the groove. There are about 20 pairs of pores ; and the pores of each pair are separated by a small tubercle.

The antero-lateral petals are large, long, deep, and straight ; they are broadest on the outer third ; and the anterior poriferous zone is more curved than the posterior, which is slightly the shortest. The pores are numerous, are on the vertical sides of the ambulacra, are large, very conjugate, and separated by wide ridges ; they are smallest near the ocular plate. There are about 40 pairs in the anterior poriferous zone, which

* See Plate IV. Part I. Echinoidea from the infra-Trap.

measures 21 millim. in length. The interporiferous zone is broad, and occupies nearly the whole breadth of the floor of the groove; it is narrower than a poriferous zone. The angle made by the antero-lateral ambulacra is 120° .

The postero-lateral ambulacra, 15 millim. in length, are straight, ovate-lanceolate, deep and narrow, form an angle of about 55° ; and their pairs of pores (about 30 in number) are large, placed on the nearly vertical sides of the groove, and are separated by wide costal projections. The interporiferous zone is large, and occupies the surface of the ground-floor.

The apical system is broken, and nothing satisfactory can be made out about the number of the plates and pores; but, from the large size of a posterior pore and the very narrow ridge of the anterior interambulacrum, it is probable that there were only one pair of generative pores.

The anterior interradians have sharp keels, very narrow near the apex; and the plates near the ambitus are nodulose. The keel of the lateral interambulacrum is broad and not very high, and that between the posterior petals is broad and enlarges posteriorly. The posterior part of this interradian area is truncated, and forms an oval slightly re-entering surface, high up in which is the large ovoid periproct. Faint traces of a peripetalous fasciole exist, which passes far in front over the ambulacrum, and which does not enter far between the petals. The ornamentation is scanty, and consists of small flat tubercles in slightly sunken scrobicules surrounded by circlets of miliaries. The ornamentation is larger and scantier in front and beneath anteriorly. The tubercles are perforate and crenulated and weathered.

The height of the test is unknown; the length is $2\frac{2}{10}$ inches, and the breadth on a level with the apical disk is the same.

Locality. North-east of Band Vero, in the Ranikot series. Survey-number G $\frac{280}{130}$.

Illustration of the Species in Plate XX.

Fig. 9. The test, from above: natural size.

Genus SCHIZASTER, Agassiz, 1836.

Test cordiform, more or less inflated, high posteriorly and sloping to the front.

Apical system eccentric posteriorly, often to a considerable degree.

Ambulacra petaloid, unequal, sunken in deep grooves. The anterior pair flexuous, directed to the front, and not very widely divergent; the posterior pair very short and slightly arched proximally. Poriferous zones equal, pores oblong and conjugate. The odd ambulacrum sunken in a deep wide furrow, of which the margins form keels; its poriferous zones are long and composed of numerous pores, which may be disposed in crowded pairs forming a simple series, or the pores may be so crowded as to form two irregular series in each zone.

Peristome eccentric in front, bilabiate, the inferior lip very prominent.

Periproct oval, at the summit of the posterior extremity.

Two fascioles, a peripetalous and a lateral, the latter diverging from near the extremities of the anterior ambulacra and passing beneath the periproct.

Tubercles perforate, crenulate, small and crowded on the abactinal surface, but larger beneath the ambitus. The tubercles are not sunken in scrobicules, but are surrounded by a small prominent disk.

1. *SCHIZASTER ALVEOLATUS*, sp. nov. Plate XX, Figs. 10-14.

There is a crushed specimen of *Schizaster* in the collection of Echinoidea from the Ranikot series, which has much of the abactinal surface, flanks, and posterior parts preserved, and which is deficient in the actinal region. It is of a brown colour; and the anterior odd ambulacrum and the left antero-lateral petal are filled with matrix and more or less fragmentary small spines; and the crushing has forced the apical end of the anterior interambulacra downwards and has obliterated the apical system. Actinally, the broken test is filled with brown matrix with Nummulites in it. At first sight the form resembles *Schizaster Newboldi*, d'Archiac & Haime, as delineated in the 'Animaux Fossiles de l'Inde;' but when compared with the types of that species, which are preserved in the Museum of the Geological Society, it will be noticed that there are specific distinctions, especially in the relative length of the ambulacra and the number of pairs of pores in them. Moreover the condition of the specimens of *S. Newboldi* really prevents them from being of real value. It appears also that one of the three types thus named is not of the same species, or possibly not of the same genus, as the others.

The general shape is tumid, largest posteriorly, highest just behind the apical system, sloping gradually in front and rapidly down the truncated posterior portion to a sharp point of the convex and semi-keeled plastron. The test has its greatest breadth slightly behind the apical system.

The apical system is slightly posterior; its details are invisible. It is small and is placed on a depressed area between the sharp suddenly-rising anterior keels, the broader but still higher and less decided narrow ridges of the lateral interradials, and the slightly narrower and more pronounced keel between the postero-lateral ambulacra.

The anterior groove is large, deep, broad, excavated at the sides, which are high within the fasciole, flat nearly on its floor; it becomes broader and shallower towards the margin, which is moderately notched, and the groove persists slightly to the peristome. The pairs of pores are placed partly on the sides of the groove and partly on the floor—one pore (the outer and larger) being at the junction of the side and floor, and the inner and smaller obliquely in front of the other and on the floor. Each pair of pores, of which there are about 15 visible, is separated from its neighbours by a broad costal elevation, and each pore is separated from its fellow by a broad tubercle. The ornamentation of the floor of the groove is not seen, except in the form of a few very minute granules near the apical region.

The antero-lateral ambulacra are deep, slightly sinuous, rounded at the extremity,

which flares outwards slightly, narrowest and shallowest near the apical system. The sides of the groove are nearly perpendicular in the midst of the petal, and they slope at the distal and become shallow at the proximal end. The interporiferous zone is well marked and broad, but it is not as broad as one of the poriferous zones. These are unequal, the anterior being the longest and curving outwards and slightly backwards to nearly meet the straighter posterior zone, where the fasciole closes the petal. The pairs of pores are small and close together near the ocular plate; and there are about 7 small pairs in the posterior zones, and 10 in the anterior before the considerable enlargement of the pores commences to be seen. The pairs then increase rapidly in size, are placed nearly vertically, are wide apart, large, and are separated by broad costae ornamented with a linear ridge. There are about 26 large and small pairs of pores in the anterior zone. The angle formed by these ambulacra is rather less than 90° .

The postero-lateral ambulacra are about half the length of the antero-lateral, are much narrower, shallower, and form a much smaller angle. They are rather close, being separated by a keel, are deep, petaliform, rather rounded at the end, and widest at the junction of the first and second thirds of their length. The interporiferous zone is moderately broad, but it has not the breadth of one of the poriferous zones; and these are on the nearly vertical side of the ambulacra. The pairs of pores are small and close near the ocular plate, and elsewhere are wide apart and large and separated by a ridge on a costa with or without granules. There are about 15 large and small pairs of pores in the poriferous zones.

The interradial areas have the plates well marked, and they are usually gibbose, so that the vertical lines of suturing are somewhat depressed. The anterior rise as sharp keels on either side of the odd ambulacrum, and they become narrow and suddenly slope backwards and downwards in front of the line of the apical system. On either side, externally, the keel slopes suddenly to the margin of the antero-lateral ambulacra; and in front the keels become wider apart, broader, and lower where the fasciole crosses. Beyond that spot the test swells out on either side, being faintly notched along the median line. The lateral interradials are narrowed and broadly keeled near the apex and are tumid along the plates, where there are globosities.

There is a sharp, convex, rather broad keel between the posterior ambulacra, which broadens out and becomes lower posteriorly, and it merges into an oval surface more or less truncated, on the upper part of which is a large ovoid periproct.

The peripetalous fasciole is broad at the terminations of the antero-lateral ambulacra; it passes backwards and inwards to a nodule on a plate about halfway between the end of the ambulacra and the most projecting part of the keel of the lateral interradium near the apical system. This part is narrow, and becomes small near the nodule. A small portion of test is between the fasciole and the posterior poriferous zone. Then the fasciole, diminished in size, reaches the projection on the keel, and thus is well within the space between the petals. Still narrowing, it reaches the edge of the posterior ambulacra at their outer third, passes round the end of the

petal, and crosses directly over the keel to the other side. In front, the broad fasciole at the end of the antero-lateral ambulacra passes forwards inwards, mounting the flanks of the keel of the odd ambulacrum to a gibbosity, and becomes narrower just before reaching this. Thence it passes forwards, widening, and then diminishing to a point on the top of the keel well forward and in front of the first visible pairs of pores. It crosses the floor of the groove in an arched form, convexity forwards. The structure is that of exceedingly minute granules.

The lateral fasciole is very narrow, and starts from the gibbosity posterior to the antero-lateral petals and about halfway between their ends. It passes obliquely backwards and downwards, and reaches the margin below the truncation for the periproct. Curving downwards around, it meets its fellow of the opposite side.

The ornamentation is remarkable. It consists at the ambitus on either side of the anterior groove of a few large tubercles on one side of a nearly circular and somewhat imbricating raised scrobicule. A few miliaries exist on the test, where there are no scrobicules. Towards the groove and above, the tubercles are closer and smaller, and they become smaller and closer on the keel and its slopes, the smallest being near the apical system.

On the flanks of the test in the anterior interradium the tuberculation is larger than on the keel, and it is comparatively wanting along the sutures and along the continuation of the petaloid ambulacral plates.

Externally and on the flanks of the test the ornamentation is at first small and close, and then it gradually increases in size and sparseness. A medium-sized tuberculation, rather close, covers the posterior interradiol. The tubercles are rather low and squat, but they have small mamelons and are perforate and crenulate. In some places there are circlelets of, or irregularly-placed miliaries; and the scrobicules sometimes are broken up, as it were, into circlelets of miliaries. On the inner slope of the keels of the anterior interradiols the tubercles are rather larger and scarcer than just on the outer slope; but they are largest nearest the pores, and become smaller in front.

The length of the specimen is $1\frac{9}{10}$ inch, the breadth is $1\frac{7}{10}$ inch.

Locality. Gari-wari Gorge, on the road from Bādha to Lynyan, in the Ranikot series. Survey-number G $1\frac{89}{129}$.

Illustrations of the Species in Plate XX.

Fig. 10. The test, from above.

11. The test, from behind.

12. Ornamentation near the ambulacra: magnified.

13. An antero-lateral petal: magnified.

14. The apical system, from a specimen from Kach: magnified. Possibly closely allied, but not of the same species.

There is considerable resemblance between this form and several species of *Schizaster*. The shape of the details of the upper surface cause it to resemble somewhat

S. d'Urbani (Forbes), of the Barton series of Alum Bay. It has considerable affinities with *S. africanus*, de Loriol, from the Nummulitic of Egypt. But the whole of the test not being accessible, it is impossible to do otherwise than state that the form belongs to the Schizasters with deep and keeled anterior grooves, deep and sinuous antero-lateral ambulacra, and small posterior petals and only two generative pores. There is a *Schizaster* from Kach which is allied to this form; but there are specific distinctions. But as it is probable that the Ranikot species had only two generative pores, we reproduce, with considerable hesitation, however, the details of the form from Kach.

Genus PREMASTER, Desor, 1853.

Test tumid, ovoid, regularly rounded in front, truncate behind.

Apical system very eccentric in front.

Ambulacra subpetaloid, narrow, almost straight; the anterior pair widely divergent, almost transverse, placed in very faint grooves, open at the extremities. The odd ambulacrum is scarcely visible, and nearly flush with the surface of the test, there being no anterior groove.

Peristome bilabiate, inferior lip prominent.

Periproct oval, at the summit of the posterior extremity.

Two fascioles, a peripetalous and a marginal. The peripetalous fasciole is incomplete and wanting in front, not extending beyond the point of junction with the marginal fasciole. This latter completely surrounds the test, dipping far down in front (sometimes so much as to appear on the actinal surface), and passing posteriorly below the periproct.

Tubercles are small and inconspicuous, perforate, crenulate, sunken in scrobicules.

1. PREMASTER OVIFORMIS, sp. nov. Plate XIX, Figs. 1-6.

The test is subovoid, long, tumid, rounded in front, at the sides, and above, and truncated behind. It is longer than broad and broader than high, and is highest centrally, and the slope is sharpest anteriorly. Below, the surface is convex.

The apical system is eccentric in front, and the peristome also. The periproct is close to the top of the posterior truncation, which merges superiorly into a projecting point.

The apical system is small; and there are four generative pores, the posterior pair being rather the widest apart. The madreporic disk, in connexion with the right anterior plate, passes backwards, separating the posterior lateral generative plates, also separating the ocular plates of the posterior lateral ambulacra in a very slight degree.

The ocular pores are small but distinct, and are at the bottom of minute hollows in their plates.

There is no anterior groove; and the very minute series of pores of the odd ambu-

lacrum are separated by a slight, flat, low ridge, which is narrow close to the apical system, and enlarges to the ambitus. The ornamentation of this wedge-shaped, triangular, and slightly elevated ridge is smaller than that of the interradians on either side. On its flanks and looking upwards and outwards are the pairs of pores of each poriferous series. They are very small, oblique, and in slight hollows; a minute tubercle intervenes between the pores of each pair, whilst the pairs are separated by a ring of miliaries.

The pores cease before the position of the fasciole is attained; and a few are visible close to the mouth.

The anterior lateral ambulacra are long, slender, narrow, crooked, nearly flush with the test (so slight is their groove), open at the end, and nearly transverse (so great is their open angle). Each ambulacrum has a decided curvature, the concavity being directed forwards in the outer half, and posteriorly near the apical system.

The interporiferous space is very narrow; and the posterior poriferous zone is slightly larger than the anterior. The pores in the anterior poriferous zones are smaller than those of the posterior, are very slightly elongate in outline; those of the posterior zone are unequal in size; the row nearest the interporiferous zone consists of smaller and circular or faintly oval or elliptical pores, whilst the posterior row contains larger pores which are elongate ellipses. The pores are conjugate and well separated; the cross-banding has a row of miliaries on it. There are about 26 pairs of pores, and those nearest the apical system are very small in proportion to the others.

The posterior ambulacra, slightly shorter than the antero-lateral, form an acute angle with each other, are in a slight groove, which is much more decided than that of the others, are closed at the end, where they are in contact with a fasciole, and are straight. Narrower than the anterior lateral, the posterior ambulacra have smaller pores, which are circular, oval, and elongate in outline. At the peristome the lateral and posterior ambulacra are represented by large wide-apart pores, and they crowd out the posterior lateral interradian areas 1 and 4 from the margin of the peristome.

The anterior interradians are rounded off; and there is a faint elevation in the angle formed by the ambulacra at the apical system; a rounded low keel is on the lateral interradians; and the posterior one has a convex surface above, which is narrowed near the apical system. Posteriorly, the odd interradian slopes slightly to the rear, and then is truncated, its direction being nearly vertical; but there is a slope backwards to the margin. This part is broad, has a very faint vertical groove below the periproct; and this is large, widely open, and nearly circular or elongate in outline.

Actually, the interradians are convex, and the posterior has a well-developed plastron between the long narrow anterior ambulacra. It has a broad low central keel reaching from the posterior projecting point forwards to the mouth, where it reaches downwards slightly, and forms the base of the hind lip. The plastron has an ornamentation of very regular hexagonal spaces, bounded by raised margins (the united scrobicular raised edges), environing a flat areola, on which, nearest one end, is a boss and mamelon, which is faintly perforate and crenulate.

The peristome is small, has a very decided posterior lip, which is on a lower plane than the rest, and the opening is broader than long. The grooves of the ambulacra are tolerably developed there.

The lateral fasciole is narrow, and slopes forwards and downwards on the flanks, close to the part of greatest bulging, so as to reach the front, below the ambitus, and about midway between the mouth and the most projecting part of the anterior region of the test. It crosses over in front of the peristome to become continuous with that of the other side. Posteriorly this fasciole suddenly dips below the periproct in a downward curve, and passes to the opposite side. It is slightly narrowest posteriorly.

The incomplete peripetalous fasciole crosses the posterior interradiial space, with a faint backward curve on a line with the ends of the posterior ambulacra. It closes their ends and then passes forwards, then curves suddenly downwards remote from the antero-lateral ambulacra, to join the lateral fasciole. It is a narrow band, and is of the same breadth as the hinder part of the lateral fasciole.

Thus the antero-lateral ambulacra are remote from the fascioles.

The test is profusely ornamented with a small tuberculation of different sizes. The smallest tubercles, situated within a raised margin in which they are sunken, are in the posterior and postero-lateral interradials above. This kind is also seen below; but the larger is observed below and especially on the plastron. In front of the descending part of the peripetalous fasciole, the raised margins are formed by aggregations of miliaries, and a larger and rounder scrobicule results with a well-developed boss and mamelon. This larger ornamentation is common over the front, except along the line of the anterior odd ambulacrum, and it is very decided inferiorly and near the peristome. The posterior ambulacra actinally and at the edge of the plastron have an ornamentation of circular minute pits.

Remarks. This species presents some resemblance to *P. Desori*, Cotteau, which is perhaps its nearest ally; but it differs from the Pyrenean species by its more elliptical form and its relatively greater disproportion of length to breadth. The test of the Sindian specimen is comparatively less high, and the truncation of the posterior extremity slopes downwards and outwards from the dorsal area. The structure of the antero-lateral ambulacra separates the form from *Agassizia*.

Length 1 inch, breadth $\frac{1}{10}$ inch, height $\frac{7}{16}$ inch.

Locality. North-east of Petiáni, Ranikot series. Survey-number G $\frac{289}{135}$.

Illustrations of the Species in Plate XIX.

Fig. 1. View from above: natural size.

2. Actinal surface: natural size.

3. Side view: natural size.

4. Posterior view: natural size.

5. Part of the odd anterior ambulacrum and ornamentation: magnified.

6. Part of an antero-lateral ambulacrum: magnified.

*Genus METALIA, Gray.*1. *METALIA SOWERBYI, d'Archiac, sp.*

Brissopsis Sowerbyi, d'Archiac (1850), *Hist. des progrès de la Géol.* t. iii. p. 251.

Brissopsis (?) *Sowerbyi, d'Archiac & Haime* (1853), *Anim. foss. de l'Inde*, p. 220, pl. xv. fig. 7 a, b.

A single example of this form, in very bad preservation, occurs amongst the Ranikot Echinoidea. The condition of the specimen is most unsatisfactory, all structure and detail having been destroyed by weathering; and we are only able to determine the species by comparison with a large series of perfectly preserved specimens from the Khirthar strata, which are identical with MM. d'Archiac and Haime's badly-preserved type specimen in the collection of the Geological Society of London. Further remarks on this species are deferred until the description of the Khirthar series; but we may, however, mention in conclusion that MM. Desor, de Loriol, and other writers have been misled, by the incorrect drawing of the form in the 'Animaux fossiles de l'Inde,' in placing the species under *Prenaster*.

Locality. North by east of Petiáni, west of Kotri, Ranikot series. Survey-number G $\frac{280}{135}$.

IV. *Remarks on the Genera and Species in the Ranikot Series.*

There are 41 species and 1 variety in this fauna. The species *Rhynchopygus Caldeyi*, d'Archiac, sp., mentioned also, was probably placed accidentally in this series by the collectors.

The number of species of regular Echini in the series, admitting the distinctness of those forms which, although they can be differentiated from their congeners, are not sufficiently well preserved to be defined specifically, is considerable. There are 17 species and one variety. There are two species of true *Cidaris* and three of *Phyllacanthus* (*Rhabdocidaris*). Moreover an examination of the spines found in the beds indicates the former presence of *Porocidaris*. The species of *Cidaris* from below the Trap is not represented in the Ranikot beds; and none of the *Cidaridæ* of these deposits pass upwards into the Khirthar series.

One species of the genus *Salenia*, characterized, however, by the presence of an optic plate within the anal ring (almost an exceptional condition in the fossil species) is represented by several specimens*. It has also a peculiarity about the ambulacral pores. The genus is not represented in the other Nummulitic strata of India.

The *Cyphosoma*, a common form, has the peculiarity of having the tubercles of the interradial areas larger than those of the ambulacra. But this is the only exception to

* See optic plates in two species figured by Cotteau, Péron, and Gauthier, *Ech. Foss. Algér.* fasc. 5.

the usual generic attributes. Another species, not sufficiently well preserved to be diagnosed, is normal in respect of the uniform size of the tubercles.

The new genus *Acanthechinus* is not without alliances with *Stirechinus*, a Miocene or Pliocene form from the Sicilian Tertiaries; and the singular genera *Eurypneustes* and *Æolopneustes* are unique, although they clearly represent such genera as *Micropsis* and *Orthopsis*, which are common in other Nummulitic faunas. But the generic distinctions are very evident.

The most interesting forms of the Echinoidea in the collection are those which must be temporarily classified amongst the Temnopleuridæ. The apical system and ornamentation of the *Dictyopleuri* separate them from *Temnechinus* and *Temnopleurus*. The ornamentation recalls that of *Glyphocyphus* and *Temnechinus lineatus*, Duncan, of the Australian Cainozoic strata. It greatly resembles that of the forms classified by d'Archiac and Haime under the genus *Temnopleurus*, they not being *Temnopleuri* on account of the absence of true pits at the angles of their sutures. They have not the apical system perfect; and we range them in our genus *Dictyopleurus* provisionally, trusting to obtain perfect specimens from higher horizons.

With regard to *Arachniopleurus*, it has a considerable range in space, as we have seen specimens collected in Persia and also in Kach. Probably *Paradoxechinus* of Laube, from the Australian Cainozoic (Tertiary), links our *Dictyopleurus* to *Arachniopleurus*. None of these forms have the true Temnopleurid penetration and undermining of the test; in fact, they have greater alliances with *Glyphocyphus* than with *Temnopleurus*; but the apical system of *Glyphocyphus* differs. Neither in the Egyptian nor European Nummulitic areas have these remarkably ornamented genera been distinguished; and *Glyphocyphus* belongs to the Upper-Greensand age.

With regard to the form *Progonechinus Eocenicus*, we have with some hesitation placed it amongst the Temnopleuridæ; its position in the family depends on the normal nature of the cavities which exist at the angles of the sutures. The ornamentation is totally different from any known genus, however.

With regard to the forms usually classified under the genus *Conoclypeus* by palæontologists, it must be remembered that Zittel ('Handbuch der Paläontologie,' vol. i. p. 515) has proved that *Conoclypeus conoideus*, Iamarek, has auricles and jaws, and that de Loriol has shown ('Echinides de l'Égypte,' p. 76 *et seq.*) that several other so called species of *Conoclypeus* have not jaws. The possession of jaws is generic, and it is accompanied by an absence of phyllodes, or doubling of the ambulacral pores near the peristome. On the other hand the absence of jaws and the presence of a phyllode take the species out of the genus *Conoclypeus*. Some of the species formerly classified with the genus *Conoclypeus* will now, on account of their having a phyllode, small bourrelets, and no jaws, be placed as a new genus, *Phylloclypeus*, de Loriol. Others are species of *Echinolampas* according to de Loriol, such, for instance, as *Conoclypeus Osiris*, Desor, from Egypt.

The new forms from Sind are readily distinguishable from the Egyptian types

published by de Loriol, and from those described by d'Archiac and Haime from Sind.

Conoclypeus declivis is not without its alliances with *Conoclypeus subcampaniformis*, Bittner, from the Eocene of the Istrio-Dalmatian area.

The portion of a test which shows a phyllode, on Plate XII, Fig. 8, came from a Conoclypeoid-looking test. But there are evidently additional or intercalated plates in the ambulacrum; and the pores penetrate through them, and are not simply in the line of the sutures. The specimen does not appear to belong to the genus *Echinolampas*; and we introduce it into de Loriol's new genus *Phylloclypeus*.

Probably *Phylloclypeus* will eventually be admitted to be a subgenus of *Echinolampas*. At present we associate it with the Echinolampinæ as a subfamily of Cassidulidæ.

The genus *Plesiolampas* has one species in the strata below the Trap, or in the *Cardita-Beaumonti* beds (*Plesiolampas elongata*, nobis); and there are five well-marked species in the Ranikot series. There are none in the higher horizon of the Khirthar series, nor are any species amongst the collections from Kach. There are no forms resembling any of the genus in the collections of d'Archiac and Haime, nor, in fact, in any others.

The numerous specimens in a good state of preservation and of different stages of growth have enabled us to give the minute details of the test in young and old specimens. There are certainly no jaws, and the phyllode is rudimentary. The inequality of the length of the poriferous zones is found in the young forms only; and the periproct becomes more totally inframarginal and longitudinally elongate with age.

The genus does not appear to be represented elsewhere than in Sind and (excepting the solitary species below the Trap) in the Ranikot series, of which it is characteristic.

MM. d'Archiac and Haime described a Cassidulid under the name of *Eurhodia Calderi*, but could give no satisfactory account of its geological horizon. The type in the collection of the Geological Society of London is not in good condition; and a specimen amongst those from the Ranikot group is in a moderately good state of preservation. But the collectors doubted the finding the specimen *in situ*; and on referring to the Khirthar series, which overlies the Ranikot, we find amongst the specimens derived from it numerous forms presenting the same kind of colour and mineralization. The form may or may not belong to the Ranikot series, and we enter it with doubt. It is a *Rhynchopygus*, however, and not a *Eurhodia*. We fail to see that the type of *Eurhodia Calderi* in the collection of the Geological Society is a *Eurhodia*; it is a *Rhynchopygus*.

The *Rhynchopygus pygmaeus* might be at first sight taken for a young *R. Calderi*; but it is not so. It differs from the Egyptian forms described by de Loriol; and from its mineralization there is no doubt about its being a true Ranikot form.

A species of *Cassidulus* is amongst the Ranikot series; and the specimens show the

beautiful floscelle and the posterior median line of cribriform structure. The posterior development of the test separates the species from all others of the genus.

The genus *Paralampas* recalls parts of the generic distinctions of both *Rhynchopygus* and *Catopygus*. The forms included within it are very perplexing in a classificatory sense; and, much as we regret having to devote a new generic title to them, we do not consider that they can be associated with any genus of the Cassidulids hitherto described. The remarkable peristome and its associated simple floscelle, the shape of the test, the shape and position of the periproct, the absence of the median pitted line on the concave actinal surface, the small petaloid ambulacral rosette with equal pores, and the homogeneous nature of the ornamentation of the actinal tuberculation are very distinctive.

Another Catopygian alliance is seen in the remarkable forms which are included in the genus *Neocatopygus*. The shape of the test, the small ambulacral rosette, the single series of the extrapetalous pores, and the character of the floscelle separate the genus very well from the *Catopygus* of Mesozoic age.

It is very remarkable that the only representative of the genus *Echinanthus* (Bry-nius) found in the Ranikot series should be a very anomalous one. The shape of the test, the highest part being eccentric in front, and the dwarfed anterior odd ambulacrum are very characteristic.

The genus *Eolampas* has an aborted anterior odd ambulacral petal, an anterior position of the apical system, and an open peristome with a very faint floscelle. It occurs also in the Khirthar series, which overlies the Ranikot group of strata. It might be said to represent the genus *Echinolampas* in the Ranikot series; but no true species of this genus are found therein, although they predominate in the higher groups.

The number of specimens of *Eurhodia Morrisi*, d'Archiac and Haime, sent to us renders it probable that it is a very common species. It is characteristic of the Ranikot series. The magnificent floscelle, the dimensions of the test, and the curious inequality of the breadth of the poriferous zones of the ambulacra cause the form to be very readily recognized. For such a large form the small size of the ambulacra is remarkable; but they are placed well forward. As the specimens now in the possession of the Geological Survey of India are far more perfect than those which were described by MM. d'Archiac and Haime, it has been necessary to redescribe the species to a certain extent.

There is no doubt about the presence of a fine *Prenaster* in the Ranikot series. The antero-lateral ambulacra have both of their poriferous zones developed; so the form cannot come within the genus *Agassizia*. The nearest alliance of the form is with *Prenaster Desori*, Cotteau; but there are good specific differences between them.

A well-defined species of *Hemiaster* and a very doubtful one are in the collection. The shape of *Hemiaster elongatus*, which is a very common fossil, is remarkable; and its structural details separate it from others. The presence of only two generative pores

situated on mamelons, and the fact that the madreporic body passes backwards and separates the ocular plates, make the form to look much more modern than the Nummulitic.

There are two species of the genus *Linthia* in the Ranikot series. One is allied to *Linthia Arizensis*, d'Archiac, sp., which is found in the Nummulitic of Egypt and Europe; but it is well separated from the *Linthia* found in the strata beneath the Trap, in the *Cardita-Beaumonti* beds. The other *Linthia* is a large form not specifically distinguishable, on account of the weathering of the specimen. Its nearest ally appears to be *Linthia Delanoueï*, de Loriol, from Egypt.

A *Schizaster* is found in the Ranikot series, the description and identification of which have given much trouble. The specimen is solitary and is crushed; but some parts of the structure remain in great perfection. As it is a very striking form, we have described it, more for the sake of field-geologists who may take up the study of the Ranikot series in detail, than for the sake of the advanced palæontologist. One of our difficulties was produced by the wretched condition of the type of *Schizaster Newboldi*, D'Archiac and Haime. It is really a worthless species. The form under consideration has some resemblance to *Schizaster Africanus*, de Loriol, from Egypt.

Finally, there is an ill-preserved specimen of the genus *Metalia*. It may be the *Brissopsis Sowerbyi*, d'Archiac and Haime.

There is no doubt that this fauna of Echinoidea is a remarkably isolated one. It has no form that can be satisfactorily and decidedly stated to be identical with any European or American species. The alliance with the Egyptian Nummulitic Echinoid fauna is of the slightest description. There are no species common to this fauna and that of the strata on the same area beneath the Trap which covers the *Cardita-Beaumonti* beds, and there are no species common to the Ranikot series and the Upper Cretaceous beds of Southern India.

Making due allowance for errors in collecting specimens, the community of species between the Ranikot and overlying Khirthar series is very small, and no form passes up to the Nari group.

The grouping of the genera of Echinoidea of the Ranikot series is interesting, and it becomes all the more important in the attempt to define the geological horizon of this great vertical mass of Nummulite-bearing beds, which, however, are clearly beneath the main Nummulitic limestone of the superincumbent and unconformable Khirthar series. In the Ranikot fauna there are 41 species and a variety; and in the whole of the Echinoidean fauna from the Nummulitic strata of Egypt de Loriol notices 42 species. In this corresponding number of species none are identical, and the affinities (of two) are very slight. The generic assemblage of the Ranikot series differs, moreover, from the Egyptian. It contains a greater number of regular Echini; and only the following genera are common to both areas—*Porocidaris*, *Conoclypeus*, *Rhynchopygus*, *Hemiaster*, *Linthia*, and *Schizaster*. The great mass of the characteristic genera of the Ranikot series are not found in the Egyptian area; and, *vice versâ*, the important genera

of the Egyptian Nummulitic are not found in the Ranikot series, or are sparsely represented in species.

Thus the genera *Salenia*, *Cyphosoma*, *Acanthechinus*, the Temnopleuridæ, the genera *Eurypneustes* and *Æolopneustes*, *Phylloclypeus*, *Plesiolampas*, *Echinanthus*, *Eolampas*, *Paralampas*, *Cassidulus*, *Eurhodia*, *Neocatopygus*, *Prenaster*, and *Metalia* (in all 18 genera of the Ranikot series out of its 26 genera) are not found in Egypt.

The Egyptian fauna is rich in species of *Echinolampas* and *Macropneustes*, *Hemispatangus* and *Euspatangus*. It contains the well-known genera *Conoclypeus*, *Amblypygus*, *Orthopsis*, *Micropsis*, *Sismondia*, and *Echinocyamus*; and there is a fine group of Schizasters and Linthias. There are two Linthias in the Ranikot series and a Schizaster; but all the above-mentioned genera are absent.

The generic distribution in the two areas, although plainly Eocenic, is very different. The absence of the genera *Echinolampas* and *Amblypygus* in the Ranikot series is very suggestive, especially as they appear in the succeeding Khirthar group.

The position of the Egyptian beds, or the Mokattam series, which have yielded the Echinoidea is stated by de Loriol to be on the horizon of San Giovanni Ilarione in the Vicentin, and of the Eocene of the Canton de Schwytz. These are the equivalents of the Calcaire grossier of Paris. But the succession of beds in Egypt appears to be, from the results of the works of Fraas, Zittel, d'Archiac, and Delanoue as follows:—On the top, beds with *Ostrea flabellula*, and below it the shale containing the Echinoidea described by de Loriol. Still lower are beds with *Atruria ziczac*, and of the age of the London Clay. Zittel has discovered under the Mokattam series, which he considers Lower Nummulitic, a series which he calls the Libyan; and it includes the *Atruria-ziczac* horizon. It rests on Cretaceous sandstones.

Are the Ranikot beds of the same geological age as the Mokattam series, or do they belong to Zittel's inferior stage, which would seem to range through the age from the Chalk to the London Clay inclusive? The homotaxis of the genera of the Ranikot series is not that of the Mokattam age; and this last has greater affinities, so far as its distribution of genera is concerned, with the Khirthar strata above the Ranikot series.

The Fossil Corals of the Ranikot series were shown to belong to 50 species ('Fossil Corals and Alcyonaria of Western Sind,' Palæont. Indica, series xiv. p. 38), and that only 7 of these were identical with European species from the zones of *Nummulites planulatus* and *Cerithium giganteum*. It is a remarkable fact that the Nummulitic Echini of Kach have greater affinities with the Egyptian fauna than with that of Ranikot, and the genus *Echinolampas* predominates with *Macropneustes*.

Laube and Dames have given the data for comparing the fauna of Echinoidea of the Vicentin Eocene. In the lowest deposits of Monte Postale and Monte Spilecco there are two genera, *Cyclaster* and *Cyclopleurus*, and also *Echinolampas*, which are not found in the Ranikot, but which are in abundance in higher horizons in Sind. At San Giovanni Ilarione there are the genera *Cidaris*, *Porocidaris*, *Cyphosoma*, *Pyrina*, *Echinocyamus*, *Amblypygus*, *Nucleolites*, *Pygorhynchus*, *Ilariona*, *Echinolampas*, *Oviclypeus*, *Conoclypeus*,

Cyclaster, Linthia, Schizaster, Pericosmus, Prenaster, Metalia, Gualteria, Peripneustes, and Euspatangus.

Bittner described some of the Echinoidea of the older tertiaries of Vicenza and Verona in 1880-1881 *, and mentions the genera *Cidaris* (*Leiocidaris*), *Leiopedina*, *Ceratomus*, *Cassidulus*, *Echinanthus*, *Pygorhynchus*, *Ilariona*, *Echinolampas*, *Conoclypeus*, *Hemiaster*, *Linthia*, *Schizaster*, *Pericosmus*, *Prenaster*, *Parabrissus*, *Toxobrissus*, *Peripneustes*, *Lovenia*.

The Eocene strata of Istria and Dalmatia have had their Echinoid fauna studied and admirably described and illustrated by Taramelli and Bittner†. The fauna is tabulated by Bittner, who finds the following genera represented:—*Cidaris* (*Leiocidaris*), *Porocidaris*, *Pseudodiadema*, *Cælopleurus*, *Cyphosoma*, *Micropsis*, *Echinocyamus*, *Caratomus*, *Amblypygus*, *Nucleolites*, *Echinanthus*, *Pygorhynchus*, *Echinolampas*, *Conoclypeus*, *Cyclaster*, *Hemiaster*, *Linthia*, *Schizaster*, *Pericosmus*, *Prenaster*, *Gualteria*, *Macropneustes*, *Peripneustes*, *Euspatangus*.

The principal genera, or those affording the greatest number of species, are *Cidaris*, *Echinanthus*, *Echinolampas*, *Linthia*, and *Schizaster*. There are no less than twelve species of *Echinolampas*. This does not resemble the Ranikot fauna.

The Etage Montien (the inferior Eocene of Belgium) contains two species of *Cidaris*, *Goniopygus minor*, *Cassidulus elongatus*, *Echinanthus Corneti*, and *Linthia Houzeaui*. Above this horizon, in the Landenian, come *Holaster*, *Hemiaster*, and *Schizaster*, with *Ostrea bellovacina*, and still higher, in the Yprésien supérieur, with *Turbinolia sulcata* and *Nummulites planulatus*, the genera *Maretia*, *Schizaster*, *Scutellina*, and *Cidaris*. In the higher horizon with *Nummulites lævigata*, the genus *Echinolampas* comes in, with *Echinocyamus*, *Lenita*, and *Spatangus*.

In the London Clay the genera are *Cidaris*, *Echinus*, *Echinopsis*, *Cælopleurus*, *Spatangus*, *Hemiaster*, *Euspatangus*, and *Schizaster*.

It is hopeless, after studying these details, to give the Ranikot series any definite equivalency. The indefinite Cretaceous facies of part of the Ranikot and sub-Trip faunas, and the absence of very distinctive Lower Eocene genera of European or African types in them, would seem to place the series lower than the Mokattam group and the fossiliferous Eocenes of Kach. At the same time the evidence given by the corals indicates a moderate alliance with the fauna of the lowest Nummulitic age of Europe and a possibly greater antiquity. It must be remembered that the Ranikot series is beneath the great development of Nummulitic limestone which occurs in the superincumbent and unconformable Khirthar series. It appears that there is some alliance between the Ranikot series of Echinoidea and those from the Cainozoic (Miocene ?) of Australia (Duncan, Quart. Journ. Geol. Soc. vol. xxxiii. p. 42); but it is of the slightest description. There is little to be said regarding the affinities of the Echinoidea of the Arrialoor or

* Beiträge zur Pal. von Oesterreich-Ungarn (Wien, 1881), Bd. i. Heft 2.

† Taramelli, 'Atti del Reale Istituto Veneto,' 1873-74, t. iii. ser. 4, p. 951; Bittner, 'Beiträge zur Pal. von Oesterreich-Ungarn' (Wien, 1880), Bd. i. Heft 1.

Upper Chalk of the south of Hindostan and those of the deposits above the Cretaceous in Sind. Yet there is a slight Cretaceous facies in the Ranikot Echinoid fauna ; but the palæontological break is still vast. From our present knowledge, then, the Ranikot series is the lowest in the Nummulitic group, and its fauna is a very special one. The series is older than the Kach, Egyptian, and Southern Alpine groups of Echinoid-bearing strata ; and these are more on the horizon of the succeeding Khirthar series.

Position of the Fossil Echinoidea.

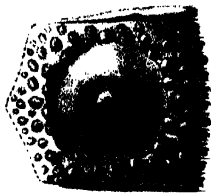
The species which were described in the first part of this Monograph, pages 7–20, were collected in strata containing *Cardita Beaumonti* and the Corals described in the ‘Palæontologia Indica,’ ser. xiv. 1880.

A trap covers the *Cardita-Beaumonti* strata ; and hence the specimens have been occasionally stated to have come “from beneath the Trap.” But it appears that a second trap (and possibly a third) exists in relation to these strata (see ‘Memoirs of the Geological Survey of India,’ vol. xvii. pt. 1, “The Geology of Western Sind,” by W. T. Blanford, F.R.S., pages 129–134).

The fact that a great depth of strata, not of marine origin, overlies the *Cardita-Beaumonti* series, which in turn are overlain by the fossiliferous strata of the Ranikot series, suffices to distinguish the age and position of the two sets of Echinoidea.

• PLATE V.

- Figure 1. *CIDARIS*, sp. (page 25). An interrarial plate, magnified.
2. A section of a plate, magnified.
 3. A portion of an ambulacrum, magnified.
 4. *PHYLLACANTHUS*, sp. (page 28). Part of a test, natural size.
 5. A plate, magnified.
 6. *CIDARIS VERNEULI*, D'Archiac and Haime (page 26). A plate, natural size.
 7. A plate, magnified.
 8. A section of a plate.
 9. *PHYLLACANTHUS RANIKOTI*, Duncan and Sladen (page 27). The plates, natural size.
 10. An interrarial plate, with a portion of an ambulacrum, magnified.
 11. *PHYLLACANTHUS SINDENSIS*, Duncan and Sladen (page 27). A part of the test, natural size.
 12. A portion, magnified.
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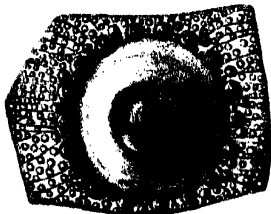
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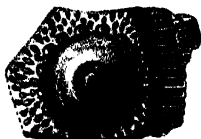
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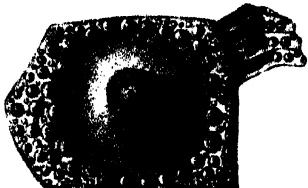
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PLATE VI.

Figure 1. *SALENIA BLANFORDI*, Duncan and Sladen (page 29). The test, side view, natural size.

2. The apical system and upper surface of the test, magnified.
3. A larger specimen showing the actinal surface, slightly magnified.
4. The abactinal surface, magnified.
5. A specimen, natural size.
6. A portion of an ambulacrum, magnified.
7. Three plates in the interradium with tubercles, magnified.
8. A young specimen, magnified.

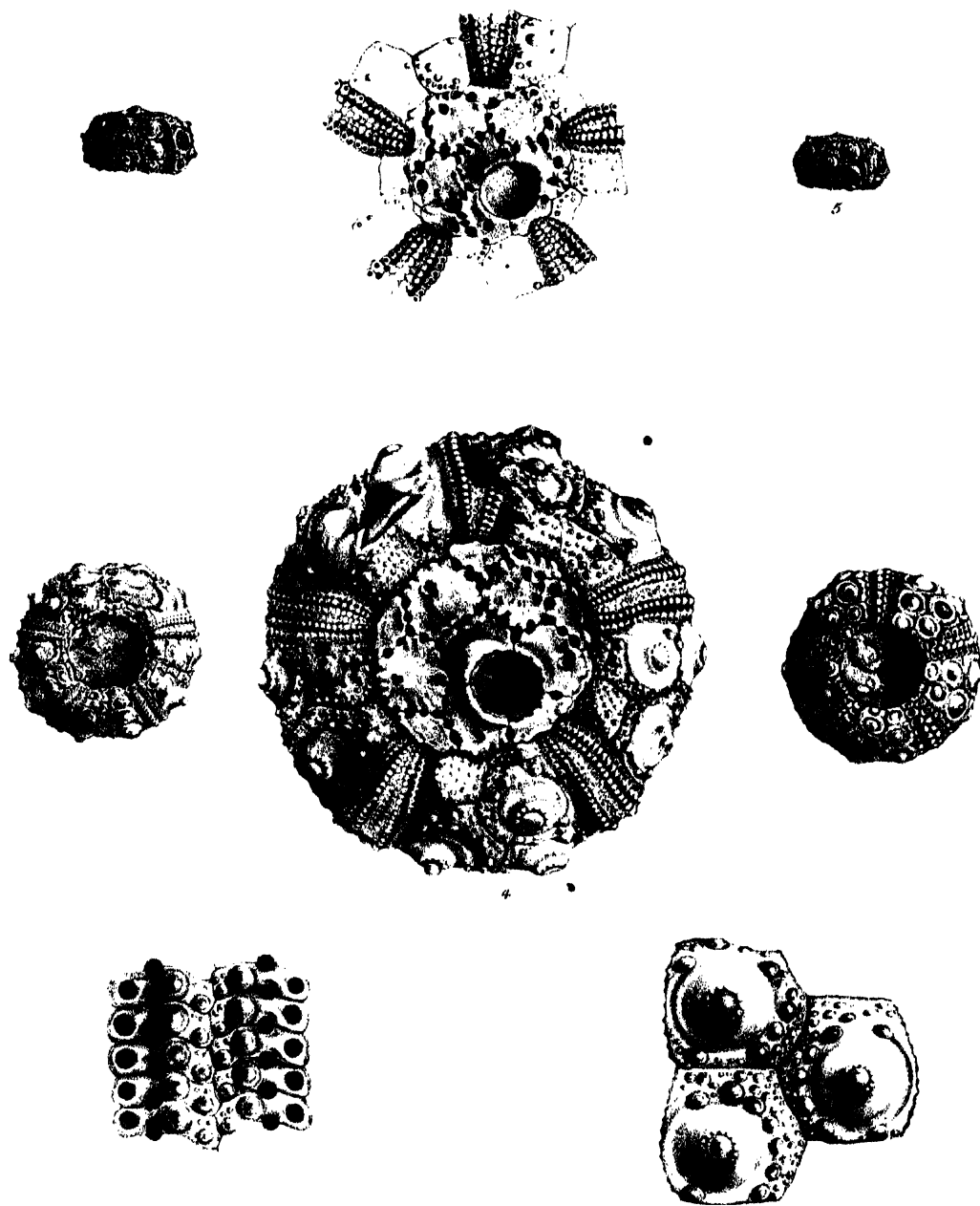


PLATE VII.

Figure 1. *CYPHOSOMA ABNORMALE*, Duncan and Sladen (page 32). The side view of a large specimen, natural size.

2. The abactinal surface, slightly magnified.
3. A small specimen, magnified 2 diameters.
4. An ambulacrum of the large specimen (Fig. 1), magnified.
5. Interradial tubercles and pores of the smaller specimen (Figure 3), near the ambitus, magnified.
6. The poriferous zone and the adjoining ambulacral and interrarial plates near the peristome of the larger specimen, magnified.
7. An interrarial tubercle and plate of the large specimen, magnified.
8. A young specimen, natural size.
9. The poriferous zone and adjoining ambulacral and interrarial plates of Figure 8, magnified.

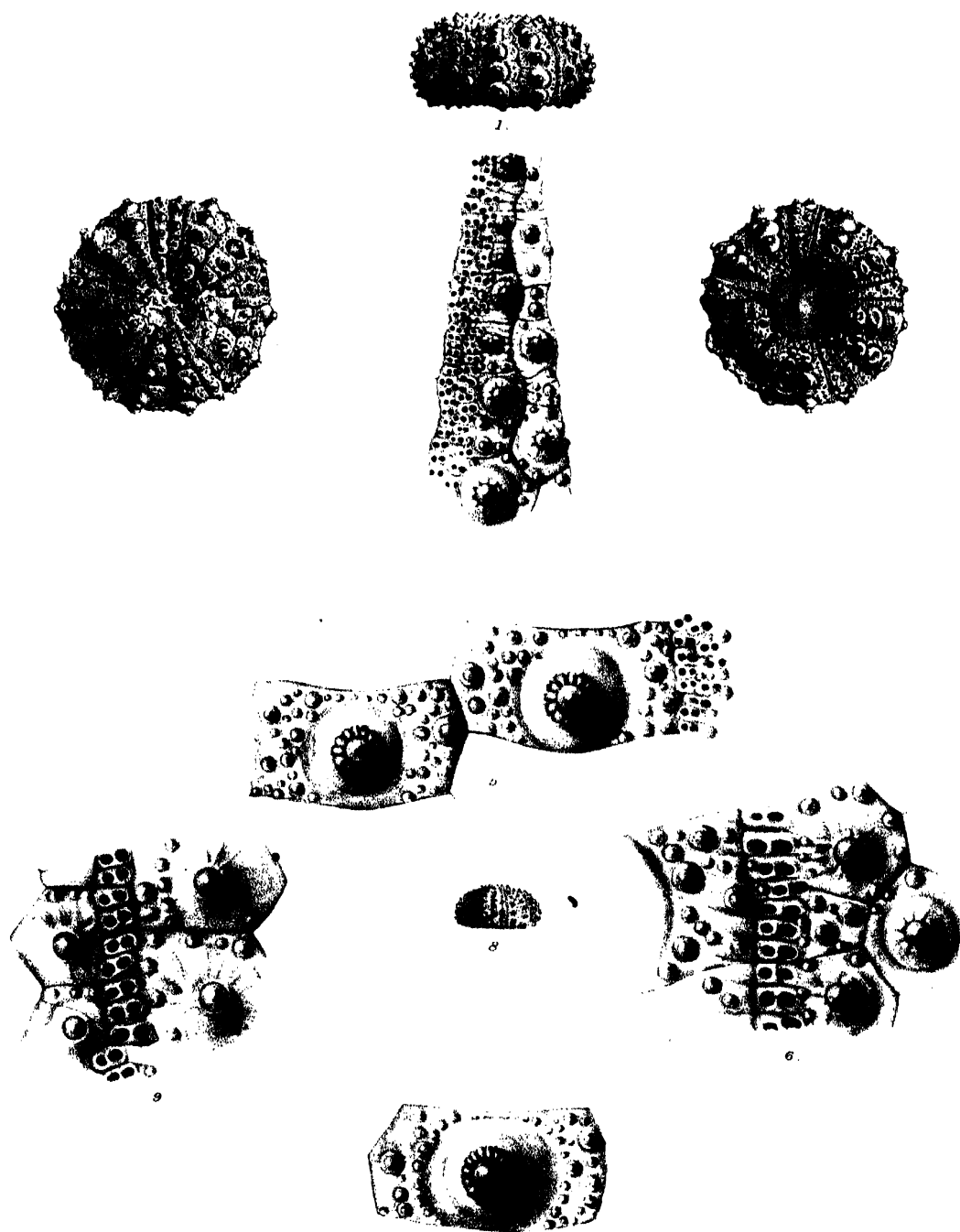


PLATE VIII.

Figure 1. *ACANTHECHINUS NODULOSUS*, Duncan and Sladen (page 34). The test, natural size.

2. Ambulacral and interradial plates near the ambitus, magnified.

3. A primary tubercle, magnified.

4. *EURYNEUSTES GRANDIS*, Duncan and Sladen (page 46). Fragment of the test, natural size.

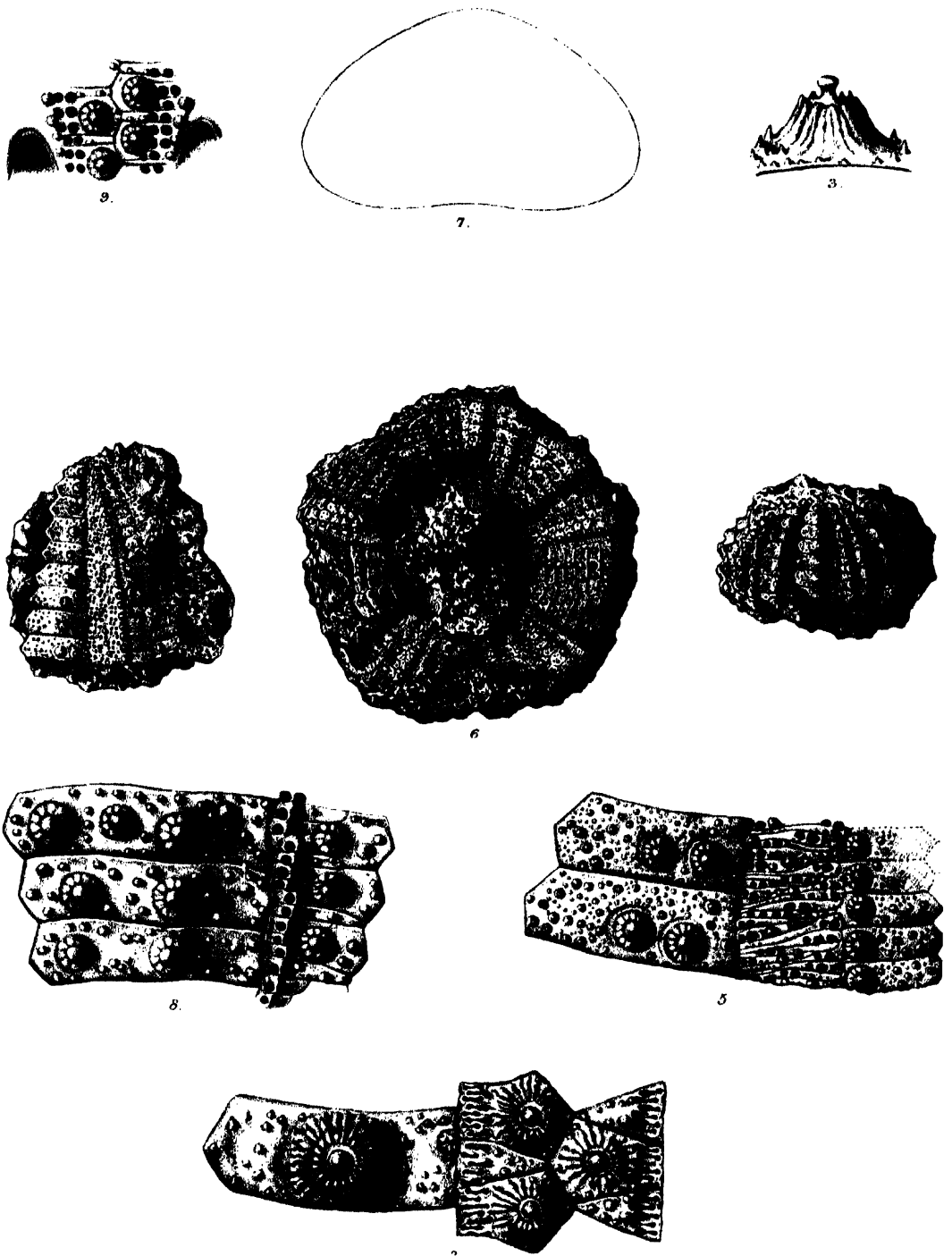
5. Ambulacral and interambulacral plates, magnified.

6. *EOLOPNEUSTES DE LORTOLI*, Duncan and Sladen (page 48). Actinal view of the specimen, natural size.

7. Outline of the profile of the test.

8. Ambulacral and interambulacral plates, magnified.

9. A portion near the peristome, showing the cuts, magnified.



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PLATE IX.

- Figure 1. *Dictyopleurus ziczac*, Duncan and Sladen (page 38), natural size.
2. The apical system, magnified.
 3. Part of an ambulacrum and interambulacrum, magnified.
 4. *Dictyopleurus haimei*, Duncan and Sladen (page 39), natural size.
 5. Part of an ambulacrum and interambulacrum, magnified.
 6. *Arachniopleurus reticulatus*, Duncan and Sladen (page 42), natural size.
 7. Part of an ambulacrum and interambulacrum, magnified.
 8. Some ridges near the apical system, magnified.

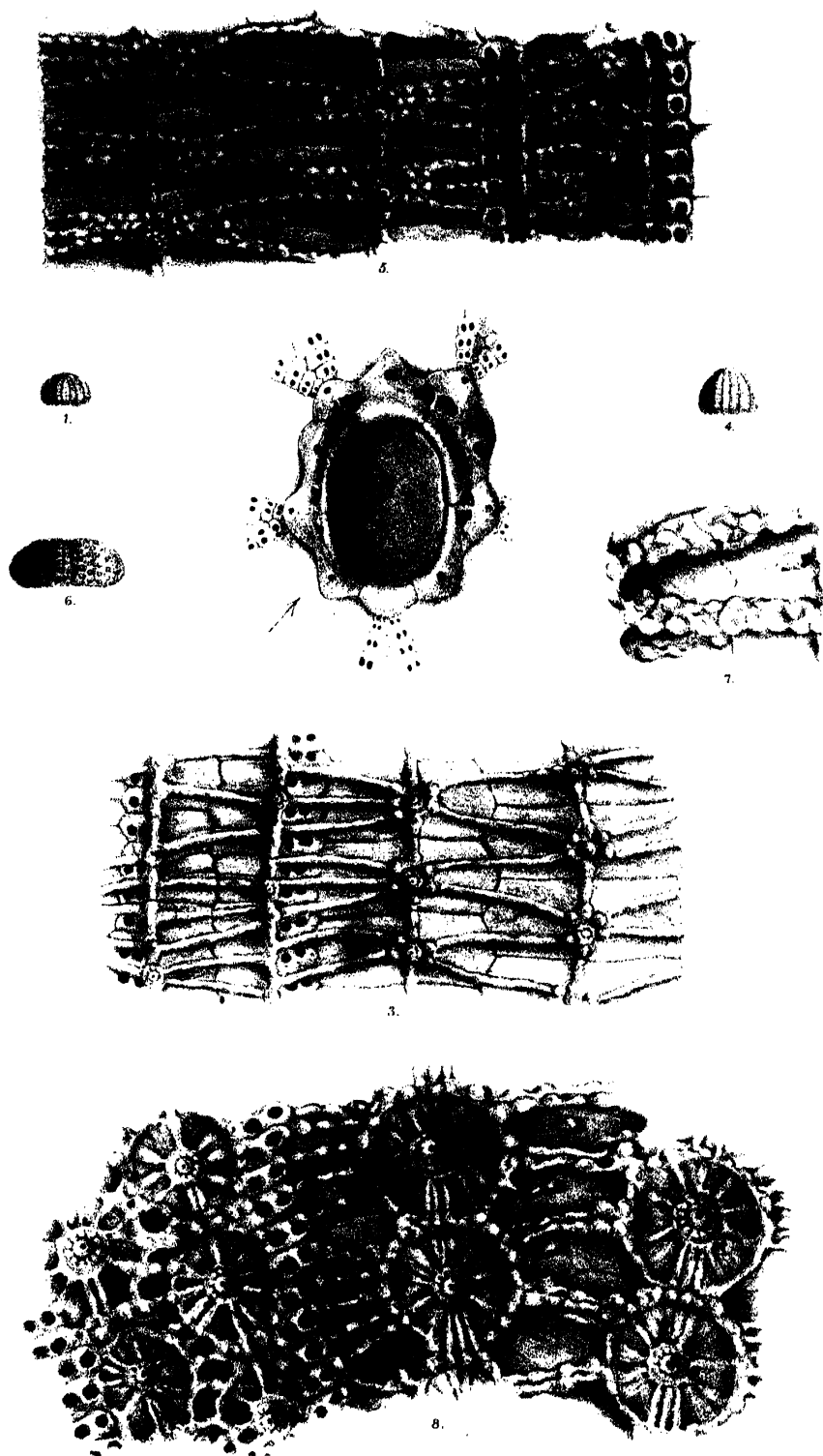
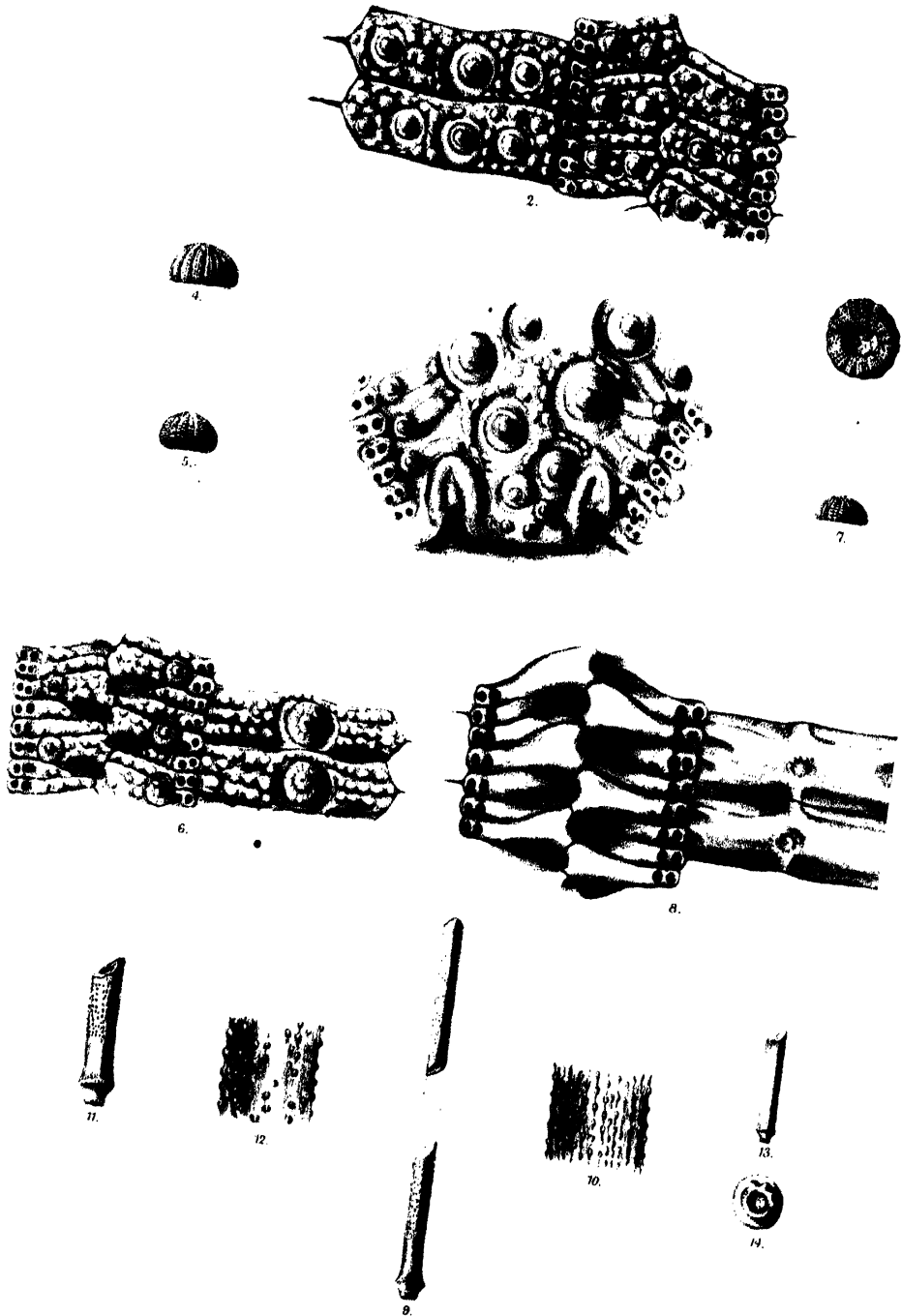


PLATE X.

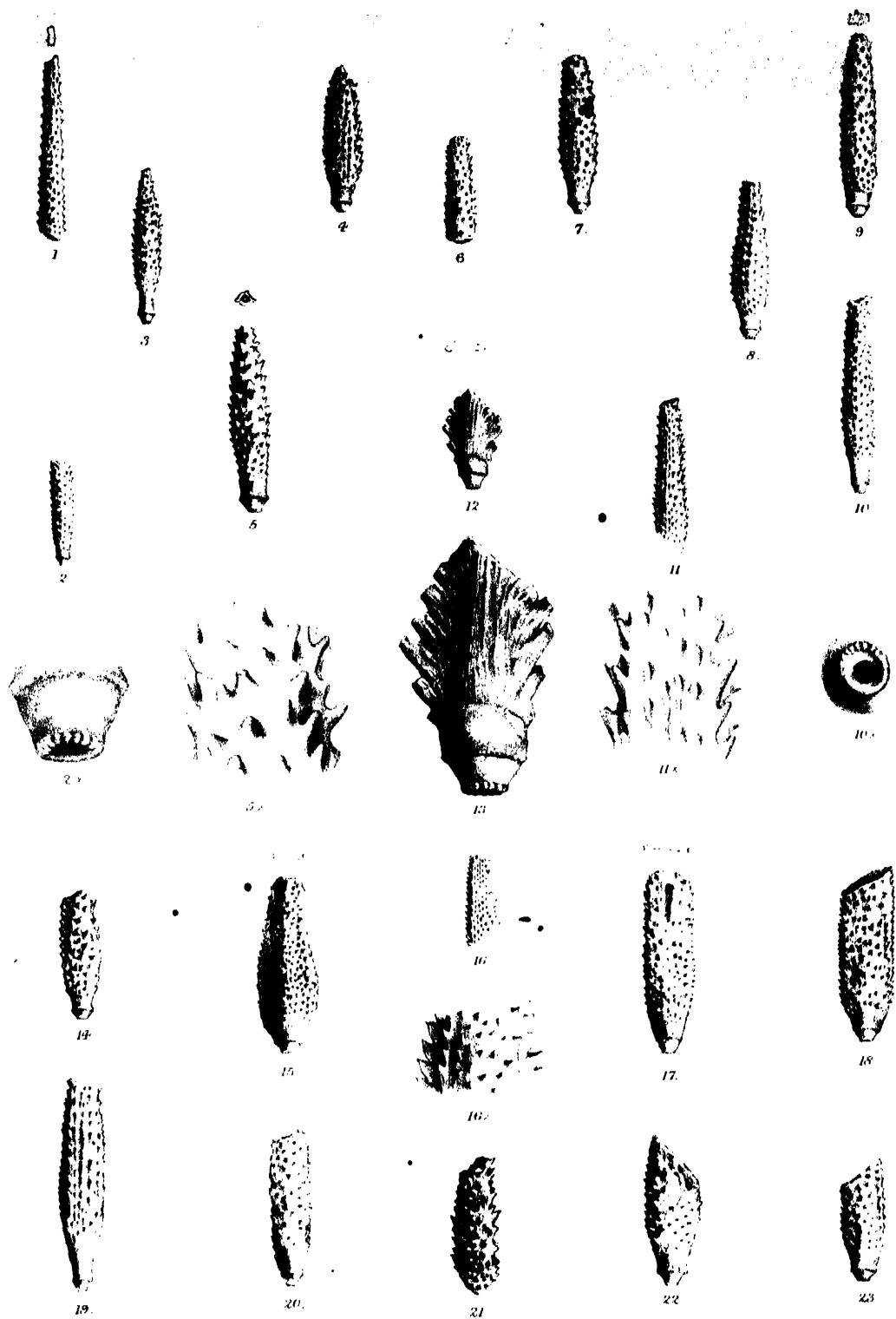
- Figure 1. *PROGONECHINUS EOCENICUS*, Duncan and Sladen (page 48), natural size.
2. An ambulacrum and part of an interradius, magnified.
 3. A portion of the test near the actinostome, magnified.
 4. A side view of the test, natural size.
 5. *DICTYOPLEURUS D'ARCHIACI*, Duncan and Sladen (page 41), natural size.
 6. An ambulacrum and part of an interradius, magnified.
 7. A weathered specimen, natural size.
 8. The same, part of an ambulacrum and interradius, magnified.
 9. A spine of a species of *CIDARIS* (page 50), natural size.
 10. A portion, magnified.
 11. A spine of a species of *CIDARIS* (page 50), natural size.
 12. A portion, magnified.
 13. A small spine of a *CIDARIS* (page 50), natural size.
 14. The ring around the cavity for the tubercle, showing incomplete *are*nulation, magnified.



Dunoon & Sleden dr. A. S. Ford lith.

PLATE XI.

- Figures 1-11. Spines of Cidaridae, genus *CIDARIS*, natural size. Figs. 5*, 10*, and 11*: Ornamentation, magnified. (Page 50.)
12. A spine of *POROCIDARIS*, natural size. (Page 50.)
13. The same, magnified.
- 14-23. Spines of *PHYLLACANTHUS*, natural size. Fig. 16*: Ornamentation, magnified. (Page 50.)



• PLATE XII.

Figure 1. *CONOCLYPEUS SINDENSIS*, Duncan and Sladen (page 51). The test, from below, natural size.

2. An end of an ambulacrum, slightly magnified.
3. The ornamentation of the test, magnified.
4. Part of an ambulacrum, high up, magnified.
5. A specimen of a *CONOCLYPEUS* (?) (page 52), side view, natural size.
6. Its periproct, natural size.
7. *CONOCLYPEUS DECLIVIS*, Duncan and Sladen (page 53). The test, natural size.
8. *PHYLLOCLYPEUS* (De Loriol's genus), species unknown (page 54). Phyllode, magnified.



Duncan

Fossil Echinoidea from Sind.
Ranikot Series

PLATE XIII.

- Figure 1. *Plesiolaspa rostrata*, Duncan and Sladen (page 61). The abactinal surface.
2. The side view.
 3. The periproct, natural size.
 4. *Plesiolaspa placenta*, Duncan and Sladen (page 54). Actinal surface.
 5. Another specimen, abactinal surface.
 6. Part of an ambulaerum, magnified.
 7. The peristome, slightly magnified.
 8. The peristomial margin, with an ambulaerum and faint bourrelets, magnified.
 9. The longitudinal outline.
 10. *Plesiolaspa polygonalis*, Duncan and Sladen (page 61). The abactinal surface.
 11. The longitudinal outline.

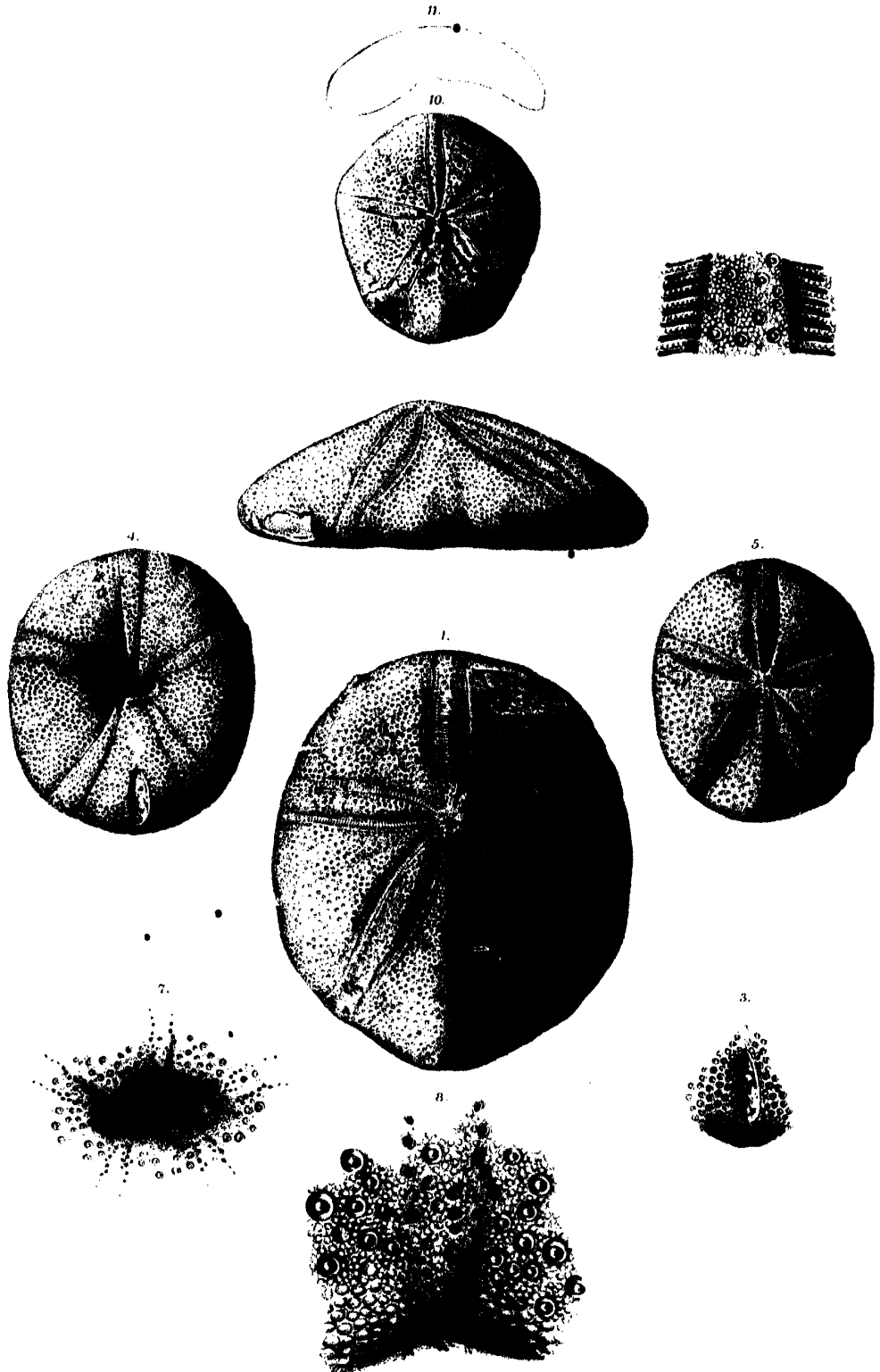


PLATE XIV.

FIGURE 1. *PLESIOLAMPAS PLACENTA*, Duncan and Sladen (page 54). The rudimentary phyllode, magnified.

2. *PLESIOLAMPAS PRÆLONGA*, Duncan and Sladen (page 56). Actinal aspect of the test, natural size.

3. Apical disk and part of the surrounding portion of the abactinal surface, magnified. Also a portion of the poriferous zone, more highly magnified.

4. *PLESIOLAMPAS OVALIS*, Duncan and Sladen (page 58). Actinal aspect of the test, natural size.

5. Portion of the median granular band leading from the peristome to the periproct, magnified.

6. Outline of the longitudinal profile of the test.

7. Abactinal aspect of another specimen, natural size.

8. Apical disk and portion of the abactinal surface of another specimen, magnified.

9. Abactinal aspect of the test of a young specimen, natural size.

10. Actinal aspect of the same, natural size.

11. Abactinal aspect of a young specimen, natural size.

12. Apical disk and surrounding portion of the abactinal surface of the same specimen, magnified.

13. Outline of the longitudinal profile of the same specimen, natural size.

14. Actinal aspect of the test of a very young specimen, natural size.

15. Outline of the longitudinal profile of the same specimen, natural size.

16. Abactinal view of the test of the same specimen, natural size.

17. Peristome of a specimen one inch in length, magnified.

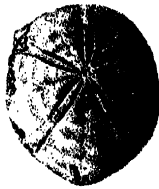
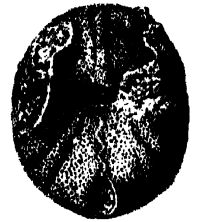
18. Apical disk and surrounding portion of the abactinal surface of the test of the same specimen, magnified.



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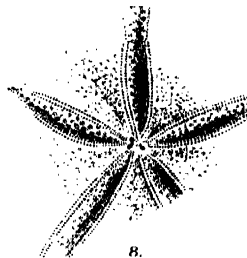
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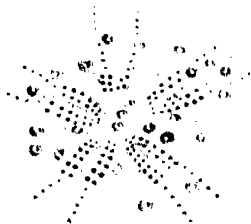
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PLATE XV.

- Figure 1. *RHYNCHOPYGUS CALDERI*, d'Archiac and Haine, sp. (page 67). Side view, natural size.
2. From behind, natural size.
3. The odd ambulaerum, slightly magnified.
4. The pitted structure of the actinal median area, magnified.
5. *RHYNCHOPYGUS PYGMÆUS*, Duncan and Sladen (page 68). The test, from above, natural size.
6. Part of the phyllode and pitted structure, magnified.
7. *CASSIDULUS ELLIPTICUS*, Duncan and Sladen (page 65). The test, from above, natural size.
8. The transverse section, natural size.
9. The floscelle and ornamentation, magnified.
10. The ornamentation of part of an ambulaerum.
11. *PARALAMPAS PILEUS*, Duncan and Sladen (page 73). The side view of the test, natural size.
12. The posterior view, natural size.
13. The marginal outline, from the actinal side.
14. The abactinal area, magnified.



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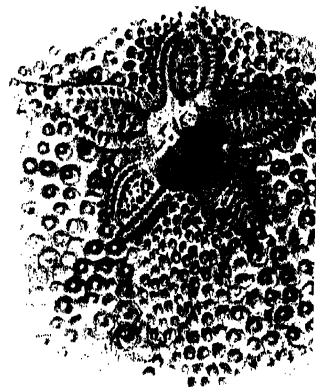
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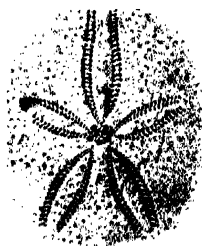
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PLATE XVI.

Figure 1. *NEOCATOPYGUS ROTUNDUS*, Duncan and Sladen (page 76). The test, from above, natural size.

2. The test, from below, natural size.
3. The floscelle and peristome, magnified.
4. A side view of the test, natural size.
5. The posterior view, magnified.
6. The transverse outline.
7. The apical system, magnified.
8. A small specimen, from above.
9. The ornamentation, magnified.
10. Part of an ambulaerum, magnified.

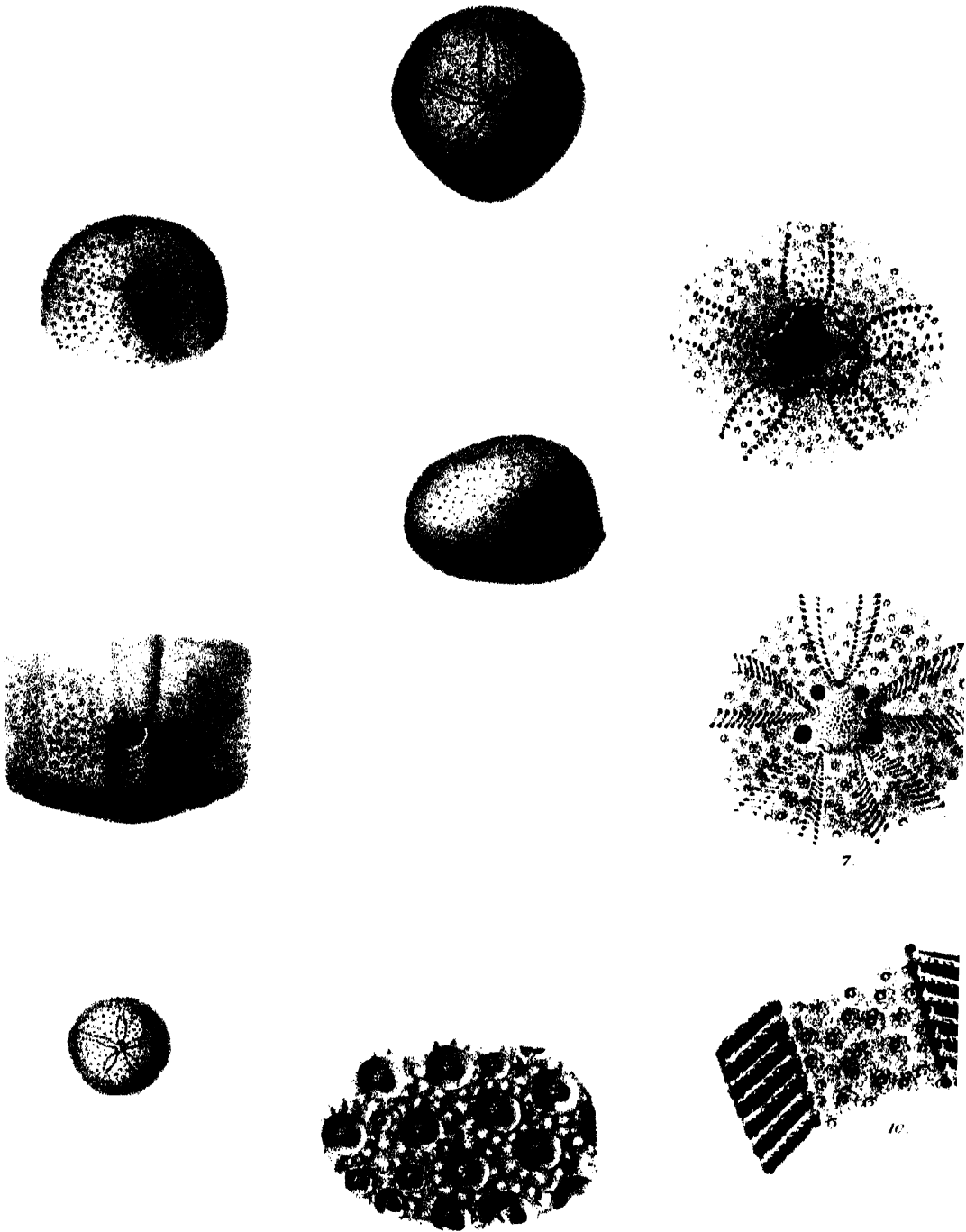
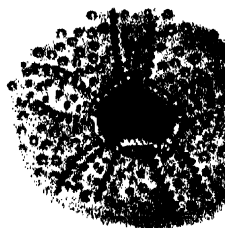
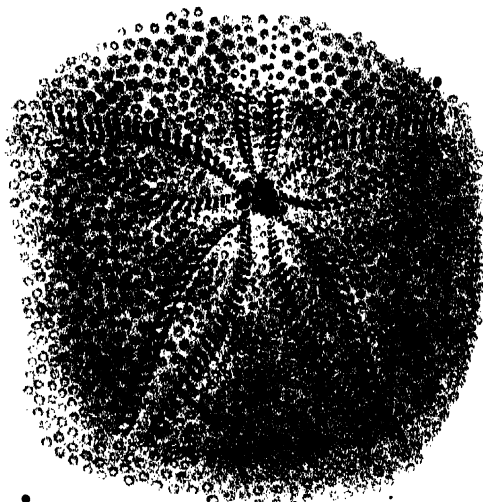
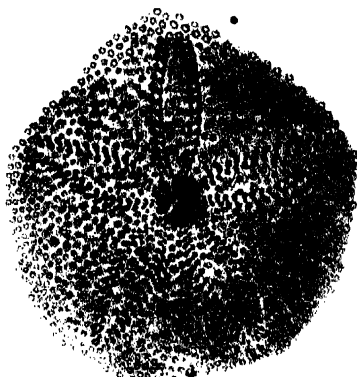


PLATE XVII.

- Figure 1. *PARALAMPAS MINOR*, Duncan and Sladen (page 74). View from the side, natural size.
2. View from behind, natural size.
 3. The apical system and petals, magnified.
 4. The peristome, magnified.
 5. *ECHINANTHUS ENORMIS*, Duncan and Sladen (page 64). A large specimen, side view, natural size.
 6. A smaller specimen (the type), side view, natural size.
 7. The same from behind, natural size.
 8. The apical region, magnified.
 9. The peristome, magnified.
 10. Ornamentation, magnified.
 11. *EOLAMPAS ANTECURSOR*, Duncan and Sladen (page 62). The side view, natural size.
 12. From behind, natural size.
 13. Outline of actinal surface, natural size.
 14. The apical system and petals, magnified.
 15. The peristome, magnified.



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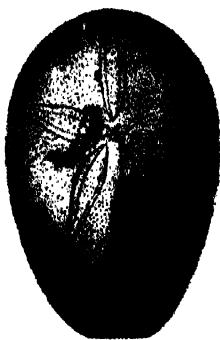


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PLATE XVIII.

Figure 1. *Eurhodia Morrish*, D'Archiac and Haime (page 70). The test, from above, natural size.

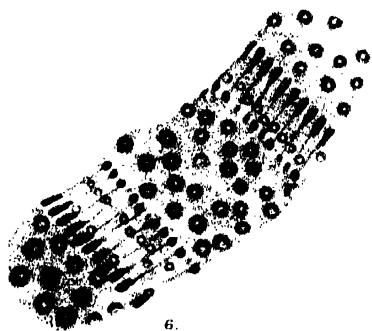
2. Side view, natural size.
3. Transverse outline.
4. Actinal surface, natural size.
5. Apical system, magnified.
6. A portion of an ambulacrum, magnified.
7. The peristome and its ornamentation, magnified.



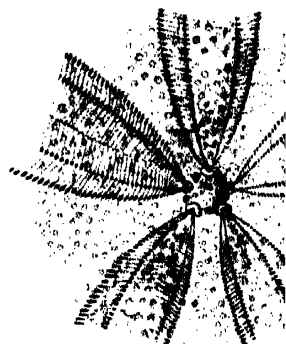
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PLATE XIX.

Figure 1. *PRENASTER OVIFORMIS*, Duncan and Sladen (page 90). View from above, natural size.

2. Actinal surface, natural size.

3. Side view, natural size.

4. Posterior view, natural size.

5. Part of the odd anterior ambulacrum and ornamentation, magnified.

6. Part of an antero-lateral ambulacrum, magnified.

7. *HEMIASTER ELONGATUS*, Duncan and Sladen (page 78). The test, from above, natural size.

8. Actinal surface, natural size.

9. The apical system, magnified.

10. Outline of side view of a specimen, natural size.

11. Part of the anterior ambulacrum, magnified.

12. }

13. } Outlines of the test of small specimens, from above, natural size.

15. The test, from behind, natural size.

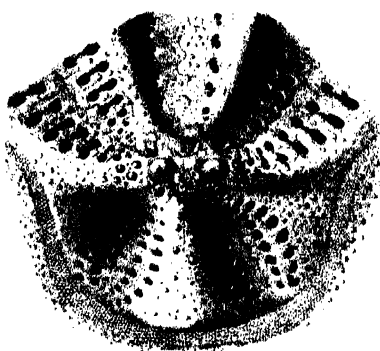
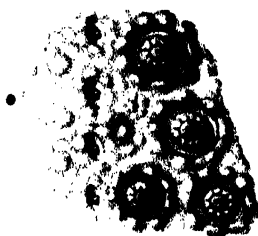
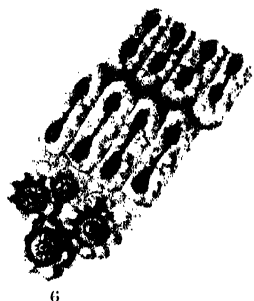
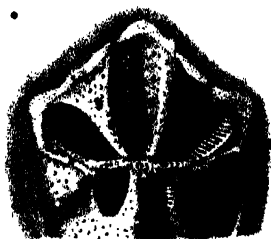
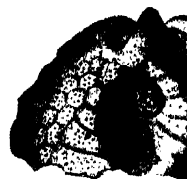
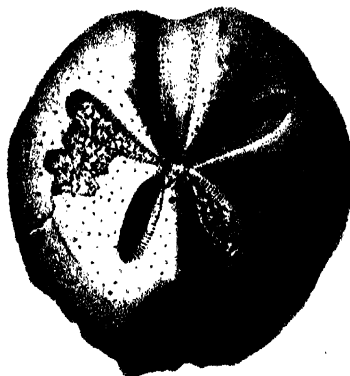


PLATE XX.

- Figure 1. *LINTHIA INDICA*, Duncan and Sladen, variety (page 82). Actinal view, natural size.
2. Side view, natural size. Specimen rather crushed.
 - 2*. Outline of test, natural size.
 3. Apical system, magnified.
 4. *LINTHIA INDICA*, Duncan and Sladen, variety (page 82). Side view, natural size.
 5. *LINTHIA INDICA*. Abactinal view, natural size.
 6. Posterior view, natural size.
 7. Young form. Side view, natural size.
 8. Posterior view, natural size.
 9. *LINTHIA*, sp. (page 85). Abactinal surface, natural size.
 10. *SCHIZASTER ALVEOLATUS*, Duncan and Sladen (page 87). From above, natural size.
 11. Posterior view, natural size.
 12. Ornamentation near the ambulaera, magnified.
 13. Antero-lateral petal, magnified, showing fasciole.
 14. Apical system of a specimen of a *SCHIZASTER* from Kach, magnified ; but it is probable that it is not of the same species as the above.



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PALÆONTOLOGIA INDICA.

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